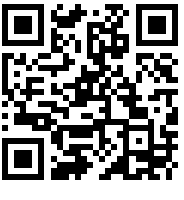
This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

Google™ books

https://books.google.com



WIDENER LIBRARY
HX H6T2 I

Digitized by Google

Digitized by Google

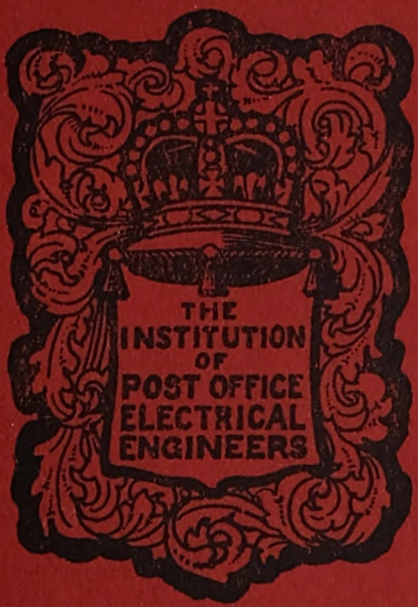
Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



VOL. 5
PART I

APRIL
1912

Digitized by Google

ADVERTISEMENT INTIVE see page xx.

ESTABLISHED 1879.

THE

LONDON ELECTRIC WIRE COMPANY AND SMITHS, LTD.

Telegrams: "Electric, London." Telephone: No. 3105 London Wall.

Playhouse Yard, Golden Lane, London, E.C.

MANUFACTURERS OF

Every Description of Cables & Wires for Electrical Purposes.

Cotton-Covered & Braided Wires, Strips & Cables.
Silk-Covered Wires for Electrical Instruments.
Enamel Insulated Wires.
Multiple Cables for Telephones, &c.
Flexible Cords of all descriptions for Incandescent Lamps, &c.
Dynamo Brushes.
"Platinoid," "Eureka," AND OTHER High Resistance Wires.

Antwerp Telephone & Electrical Works, ANTWERP.

Manufacturers of

TELEPHONIC APPARATUS

OF EVERY DESCRIPTION.

Wall Sets
Table Sets
Switchboards
Standard and Multiple
Domestic Sets

Bells
Receivers
Transmitters
All Accessories

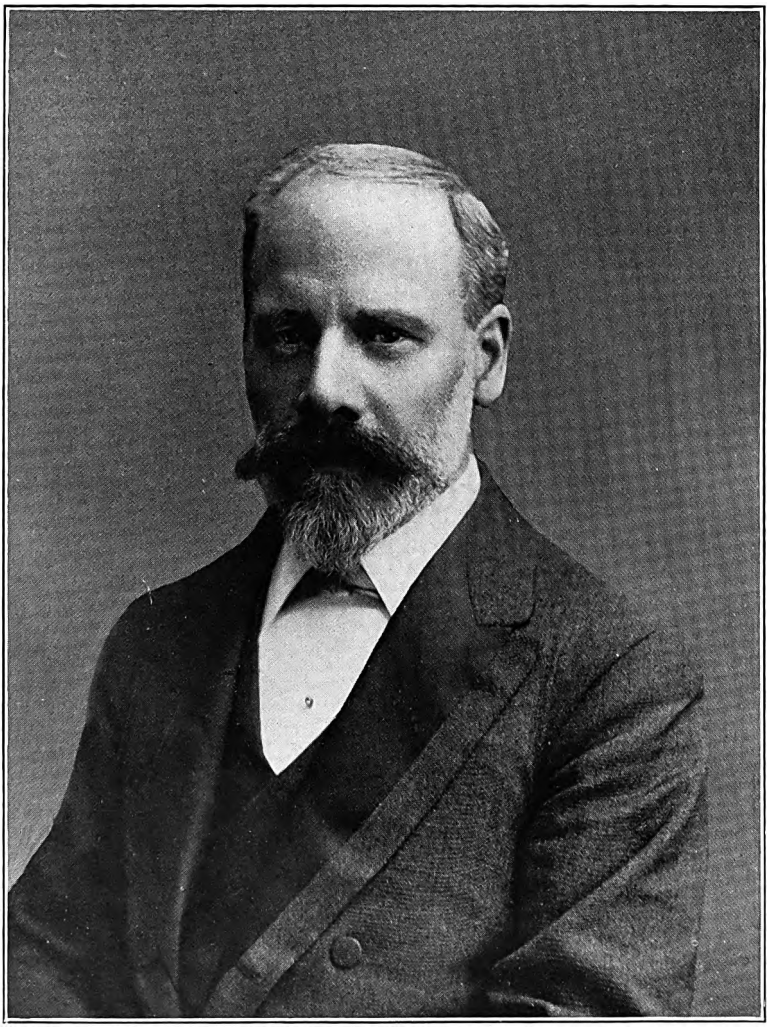
Sole Agents for the United Kingdom—

W. F. DENNIS & CO.,

49, QUEEN VICTORIA STREET,
Stores: MILLWALL DOCKS, E. LONDON.
Telegrams: "FREDENNIS, LONDON." Telephone: BANK 343.

Digitized by Google

Digitized by Google



THE NEW ENGINEER-IN-CHIEF.—MR. WILLIAM SLINGO.

Digitized by Google

Aug. 20, 1912
HARVARD UNIVERSITY
DEPARTMENT OF ENGINEERING.
Sci 1490.183

THE
Post Office Electrical Engineers' Journal

THE NEW ENGINEER-IN-CHIEF.

MR. W. SLINGO, the new Engineer-in-Chief of the British Post Office, was born in 1855, and commenced his official career as a telegraph clerk in the Central Telegraph Office in 1870, after having spent some months as a learner under the Electric and International Telegraph Company. The technical side of the work very speedily claimed his attention, and in the days when there were few books on the subject, and when no technical schools, telegraphically equipped, existed, he applied himself not only to the mastery of the subject for himself, but to supply the want for others. Mr. Slingo must unquestionably be regarded as one of the pioneers of technical education.

It was in 1872 that he made up his mind to start his studies with a view to opening a technical school. In 1874 he began his lecturing career, opening classes in Wandsworth, Kingston, Pimlico, Wapping, and other parts of London. His chief source of information was the South Kensington Museum and its Library, and he profited by courses of lectures by such giants as Tyndall, Frankland, Huxley, and Guthrie. In the summer of 1876 he regarded himself as sufficiently prepared to open the Telegraphists' School of Science in connection with the Central Telegraph Office. The classes were started in a hired schoolroom off Aldersgate Street, and his first class consisted of only five students, but the progress was steady and sure, and when in 1898 he relinquished the post of principal of what was then the largest and most successful school of technical telegraphy, telephony and kindred subjects in the Kingdom, the membership had reached the remarkable figure of 850. The equipment, too, was

Digitized by Google

complete and up-to-date, and contrasted strangely with the primitive makeshift arrangements of the early days. The work of the school was frequently reported upon very favourably by the Science and Art Department, and on several occasions Mr. Slingo was thanked in the name of the Postmaster-General.

His interest in scientific education was, however, not confined to the C.T.O. classes. A considerable amount of work was done in the cause of the better scientific training of the youth of the Metropolis in connection with the "People's Palace," now known as the East London Technical College. Mr. Slingo was head of the Electrical Department of the college, and was largely instrumental in organising and developing its technical sections. He was also keenly interested in Sir Edmund Currie's residential Engineering School at Folkestone, which he visited weekly, and where he had charge of the Electrical Engineering Department.

It will be news to most people that Mr. Slingo was largely instrumental in the formation of the City and Guilds of London Institute, and was freely consulted in the matter by the late Mr. Le Neve Foster, the then Secretary of the Society of Arts. It was solely at Mr. Slingo's instigation that telegraphy was recognised as a subject for examination by that body.

During all this time he was performing his duties, as a telegraph clerk, at the instruments until 1881 and afterwards at the test-box. During the later years he was allowed shortened hours of duty in order that he might devote more of his time to the needs of his school, but his working hours during the winter months extended as a rule from 8 o'clock in the morning until about midnight, and for many years the whole revenue of the school was absorbed in the accumulation of a unique collection of apparatus.

Of the quality of his work as technical teacher it will suffice to say that there is scarcely an engineering district or a Headquarters section in which important positions are not held by Mr. Slingo's old students.

His energies during this period were not altogether confined to the Department, as he was Consulting Engineer to the Drapers' Company and the Dover Corporation, and was responsible for the installation of the peculiarly interesting plant of the Ilford Photographic Company at New Warley.

With the passing of the school, Mr. Slingo was transferred to the Engineering Department of the Post Office, being appointed as a First Class Technical Officer. For about two years he was in charge of the Foreign Telegraph Section of the Engineer-in-Chief's office, and during this time introduced important improvements in the working of the Continental Hughes circuits and established the duplex system on a solid basis. In the course of his investigations into this

Digitized by Google

subject Mr. Slingo visited Berlin, Hamburg and other Continental cities.

An advance of even greater moment which was made during this period, and one which was designed ultimately to revolutionise battery working in all the important telegraph offices of the Post Office was the systematic application of secondary batteries to telegraph working. The initiation and rapid development of this policy, which has effected large economies in battery maintenance, was in no small measure due to the practical experience and sound judgment of Mr. Slingo. It is an interesting feature that when he designed this secondary battery system he had such faith in its success that fifteen complete equipments were ordered before a single experimental trial had been made. Ultimately about forty equipments were installed, which have in all cases worked with remarkable success.

Subsequently Mr. Slingo was for a time placed in charge of the Designs Section of Headquarters, and was the presiding genius under whose direction many of the types of a rapidly changing service were produced, and many little reorganisations introduced which placed the section on a sound footing. In December, 1903, Mr. Slingo was promoted to the position of Superintending Engineer of the North Wales District, and his administrative powers rapidly brought the Departmental engineering organisation of that important area to a pitch of perfection never previously reached. It was not the case of the " new broom " ; it was the policy of thoroughness in every detail and department of the work of which Mr. Slingo is in himself one of the most notable exponents. The completeness and efficiency with which the work of reorganisation of the district was carried out is the more remarkable when it is remembered that until his appointment to Liverpool Mr. Slingo had had no experience of district engineering work. How speedily and absolutely the details of district organisation were mastered is shown by the fact that within a year after his appointment as Superintending Engineer Mr. Slingo was made a member of the Superintending Engineers' Committee, and consequently had a large share in the preparation of the first edition of the Engineering Regulations.

In January, 1911, Mr. Slingo was appointed as Assistant Engineer-in-Chief, and since that time, in addition to carrying out the responsible administrative duties pertaining to that office, he has been very closely engaged upon work in connection with the valuation of the N.T.Co.'s plant. He has, moreover, during the past year been Chairman of the sub-committee dealing with the engineering work arising out of, and necessitated by, the transfer. Despite the fact that he has been known to pronounce somewhat emphatically in favour of " committees of one," there is no question that each of the Departmental Committees upon which Mr. Slingo has served would have been im-

Digitized by Google

measurably poorer but for his presence and sound, reliable judgment. The most valuable asset to any committee is the member who, while mastering all the details and complexities of a subject, can unerringly grip the essentials of the matter and tersely and lucidly deliver judgment upon them. Mr. Slingo is by nature and training such a member, and we have reason to anticipate that in the preparation for the coming arbitration proceedings, where breadth of view, statesmanship, and a thorough knowledge of all the intricacies of the case are required, the benefit accruing to the Department in the possession of these gifts on the part of its Engineer-in-Chief will prove to be incalculable.

Mr. Slingo's reputation as an author of technical literature is doubtless already well known to our readers. Chief among his publications is the volume on Electrical Engineering which was the product of the joint authorship of Mr. Slingo and Mr. A. Brooker. The first edition of this work was published exactly twenty-two years ago, and although it deals with a subject which, like telegraphy and telephony, is a rapidly changing and progressive one, yet it still remains an accepted text-book. This is a fact which speaks well for the care and accuracy with which the original work was done, no less than for the completeness with which the many subsequent editions of the book have been revised.

It is worthy of note that so instant was its success that within two months of its publication a reprint was necessary. The abiding usefulness of the work rests largely upon the minuteness with which the facts were verified. As a case in point we may mention that a series of original and exhaustive investigations extending over several weeks were conducted under Mr. Slingo's direction in connection with the watts absorbed per candle power for different forms of electrodes in arc lamps. It was apparently a small but in reality a most important matter, and the thoroughness with which the inquiry was pursued furnishes an excellent illustration of the labour and pains spent upon the whole.

The Electrical Exhibition at the Crystal Palace in 1881 gave Mr. Slingo an opening into technical journalism, and he contributed extensively to the technical and lay press for a number of years. He was editor of 'Knowledge,' a widely circulating scientific weekly, for a period of eighteen months, and in conjunction with Mr. Brooker, wrote an important series of articles on "Storms and Telegrams," which created some stir at the time, and was translated and reproduced in the Berne 'Journal Telegraphique.'

During his career in the Post Office service Mr. Slingo has seen enormous strides in the development of the telegraph and telephone services, and has witnessed no fewer than four transfers. During his first year of service the transfer of the telegraphs to the State took

Digitized by Google

place; in 1889 the undertakings of the Submarine Telegraph Companies were absorbed; in 1896 the Trunk telephone lines were taken over; and at the beginning of the present year the huge undertaking controlled by the N.T.Co. was transferred to the Post Office. It will be seen, therefore, that his life's work has been in and for the Post Office, and the Postmaster-General is to be congratulated upon the selection of an officer to fill the post who has won his way up from the ranks. Mr. Slingo knows both the work and the staff, and the work will assuredly not suffer because of the fact that the staff know their chief.

Mr. Slingo has taken up the reins of government in the great Engineering Department of the British Post Office at what is probably the most critical period in its history. It may be said with perfect truth that never before were so many critical eyes watching its development, or so many critical pens ready to take up the tale of its imperfections. Yet with equal truth it must be admitted that never before were the problems of organisation greater or more complex. Hence the need of the Engineering Department to-day is for a chief who is gifted with clear sight, can plan on a large scale, and can lay the foundations truly and well upon which shall be erected the edifice of a national service worthy of the best traditions of the British people. The achievement of such an ideal cannot, we know, be wrought by one man alone. It can only be accomplished by the help of a loyal, industrious, and united staff. The opportunity which lies ahead is a great, a magnificent one. We have confidence in the wisdom and justice of our new chief, and we feel sure that in the coming strenuous days he will so guide and inspire the labours of his staff as to create for himself, in their esteem and devotion, the most enduring monument which it is given to mortals to rear.

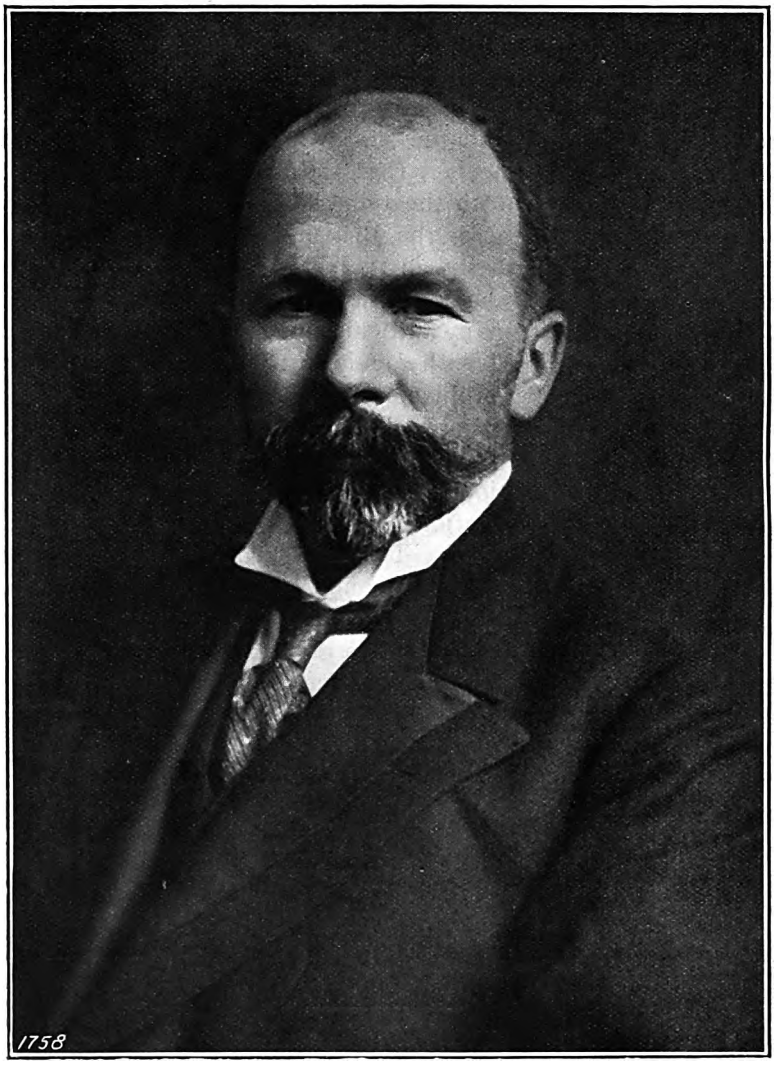
THE NEW ASSISTANT ENGINEER-IN-CHIEF.

THE announcement of the promotion of Mr. W. Noble to the position of Assistant Engineer-in-Chief is one which will be received with widespread satisfaction in the Engineering Department.

Mr. Noble entered the service of the Post Office in 1877 and was a telegraphist in the Aberdeen Office during the earlier years of his career. Like our newly appointed Engineer-in-Chief, his interest in the technical side of his work was early evidenced. After achieving a double-medal success in telegraphy and telephony, he was for some

Digitized by Google

years lecturer in telegraphy and telephony and later also in magnetism and electricity. The strenuous type of student for which the northern city is famed well accorded with the strenuous character of



A NEW ASSISTANT ENGINEER-IN-CHIEF.—MR. WILLIAM NOBLE.

the teacher, for during his period as teacher no year passed without one or more of his students obtaining that coveted honour of all science students—a medal award. It has, moreover, been a source of unalloyed gratification to him to witness the steady progress which many of his early students have made in the Engineering Department

Digitized by Google

of the British Post Office. Technical education and training, whether of messengers, fixers, linemen, or others, still claims his attention, and for some years past Mr. Noble has been one of the examiners of the City and Guilds of London Institute.

In 1893 Mr. Noble was appointed a second-class engineer at Aberdeen and in 1897 received promotion to a first-class engineership in the Engineer-in-Chief's office. Here his native ability and organising power were soon recognised and were afforded fuller scope. The period was one of rapid transition and development. The purchase of the trunk telephone lines from the National Telephone Company had been completed shortly before this, and the necessary reconstruction of many of these and the abnormal growth of the system which followed furnished problems well calculated to engage Mr. Noble's active mind. Larger developments, too, were pending. The active entry of the State into competition with the National Telephone Company was already foreshadowed and was shortly afterwards decided upon, and in the earliest preparations for that momentous undertaking Mr. Noble bore no small part. It was desirable for the success of the work that the fullest possible information should be obtained as to the Company's ways and methods, both for the purpose of emulating what was good and avoiding what was bad in the Company's system. Many of these important preliminary investigations were carried out by Mr. Noble.

In 1900 he was made a technical officer, and in the following year was made an Assistant Superintending Engineer in the Central Metropolitan District. This was the district in which both the earliest and the fiercest telephone competition was anticipated and experienced. As second in command Mr. Noble was responsible for a large share of the work which is now popularly known as the "Telephoning of London." The work was vast and ceaseless, with potentialities of worry to correspond! But it was during the four years when the heat and dust of labour was greatest that the energy and resource of the subject of our sketch was most conspicuous; and when promotion to a first-class staff engineership came in 1905 no man could say that the recipient had not fought and won his way by vigorous achievement to the higher post.

Mr. Noble's next task was to take charge of the Telegraph Section at Headquarters. For prominent among the foundations of belief upon which the policy of the Department rests is Shakespeare's dictum that on the stage of life "one man in his time plays many parts."

Incidentally it argues a remarkable versatility on the part not only of Mr. Noble, but of many of the Department's administrative officers that they can at a moment's notice completely change in

Digitized by Google

direction the current of their energies, and adapt themselves to any and every one of the complex duties which go to comprise Telegraph and Telephone Engineering. In this case heavy construction work was suddenly left behind, and intricate and delicate problems of telegraph apparatus resolutely tackled. As chief of the Telegraph Section Mr. Noble was responsible for much experimental work designed to determine the relative merits and spheres of usefulness of the different telegraphic systems then clamouring for recognition and adoption. Exhaustive experiments and many practical tests with multiplex and typewriting telegraph apparatus were carried out under Mr. Noble's direction, and, aided by a loyal and industrious staff, much useful work was done. During this period also the different types of C.B. telegraphs were first introduced and largely developed.

In 1907 Mr. Noble was appointed Superintending Engineer of the Central Metropolitan District, and his earliest efforts were directed to the improvement and consolidation of its organisation. As an administrator his zeal and energy speedily compelled recognition, and shortly after taking up duty in the Central Metropolitan District he was appointed a member of the Superintending Engineers' Committee—a position which he has held ever since. His wide practical experience and sound judgment have indeed been of peculiar value to the Department in its Committee work. The Committees upon which Mr. Noble has served are many and important. He was Chairman for about five years of the Factory Works Committee. In conjunction with Mr. Sinnott he reported on the factory repair work, and as a result of the recommendations which were made, the present system of joint examination was set up The arrangement has proved a highly satisfactory one, and has resulted in considerable economy. In 1909 a committee of three, known as the Advisory Board, was appointed, and it is safe to say that never in the history of the Engineering Department were the operations of any Committee the object of such vigilant and assiduous attention by the Staff. Mr. Noble, together with Messrs. J. W. Woods and A. J. Stubbs, Assistant Engineers-in-Chief, were selected to compose this committee, and entrusted with the task of selecting, for promotion to first-class engineerships, the more promising amongst the senior second-class engineers. Mr. Noble also acted as one of the board of selection for second-class clerkships.

In 1910 Mr. Noble was appointed by the Postmaster-General as member of a committee to consider and report upon the question of underground mail transmission in London, and in company with the Controller of the London Postal Service (Mr. R. Bruce, C.B.) visited Berlin, Vienna, and Paris, to investigate existing continental systems. More recently Mr. Noble was appointed by the Post-

Digitized by Google

master-General to serve on the Factories Committee charged with the labour of investigating the subject of factory work and costs and the conditions under which the Department's work might economically be produced. For his work on both these important committees he received the special thanks of the Postmaster-General. Mr. Noble is also the only engineering member of the Staff Transfer Committee created for the purpose of grading into existing Post Office classes the members of the late Company's staff.

It is perhaps scarcely necessary to add that with such heavy and important committee work added to the labours of chiefship of a heavily worked district Mr. Noble's energies have been taxed to the utmost. It has meant hard and unceasing toil. But it has won recognition alike from the Department and the Staff. From the former an allowance of £100 per annum for special services; from the latter a loyalty that counts for much more than gold.

Digitized by Google

332

AVENUE TELEPHONE EXCHANGE, LONDON.

By J. H. Bell.

One of the first districts to benefit by the steps which the Postmaster-General has taken to substitute up-to-date telephone facilities in centres where obsolete equipment has been in use is that covered lately by the National Avenue Exchange, Lime Street, E.C. This exchange had a special claim for prompt attention inasmuch as it had the highest calling rate in London, namely, 23·9 per line per day. A commodious new building (1) having been acquired by the Department in Cree Church Lane, E.C., a 9000 line 40-volt C.B. switchboard, with present equipment for 8100 lines, has been installed by the Peel Conner Telephone Works, Ltd. This installation, which includes many new and important features, is one of the most up-to-date in Europe, and one of great interest to telephone engineers.

The Exchange Building.—The basement accommodates the main cable chamber, battery room, stores, cloak room for linemen, and heating chamber. On the ground floor is situate the test-room, in which are the main and intermediate distribution frames, relay racks, subscribers' meter rack, power plant, test desks, and a room for engineering officers.

The first floor is given up entirely to the operating staff. Here a kitchen, a spacious dining room, and a comfortable rest-room are provided.

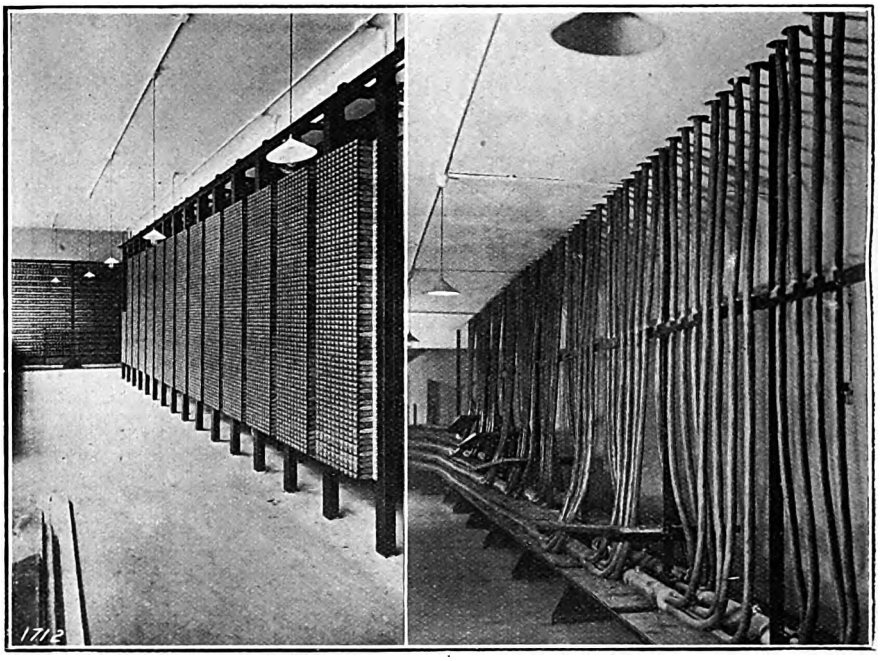
Main Cable Chamber.—Under the test-room in the basement is the main cable chamber. At this point, by means of a shaft from the street, the cables enter the building. The number of conduits at present terminating in the building is sixty. 2 gives an excellent view of the cable rack, which is of a very convenient design for the running of cables and for jointing purposes. The street cables

Digitized by Google

Digitized by Google

increased from 434 to 1600, thus greatly extending the carrying capacity of the conduit system. Owing to the number of through circuits which are led in and out of this exchange there are necessarily many cables in excess of the switchboard requirements; at present 15 cables of 1600 wires, 9 of 1200 wires, and 5 of 600 wires are connected to the main frame.

TEST-ROOM.—A general view of the test room (3) shows the position of the frames and racks; the test-desk will be observed in the foreground.



4.—NEW "AVENUE" EXCHANGE.—SUBSCRIBERS' METER RACK.

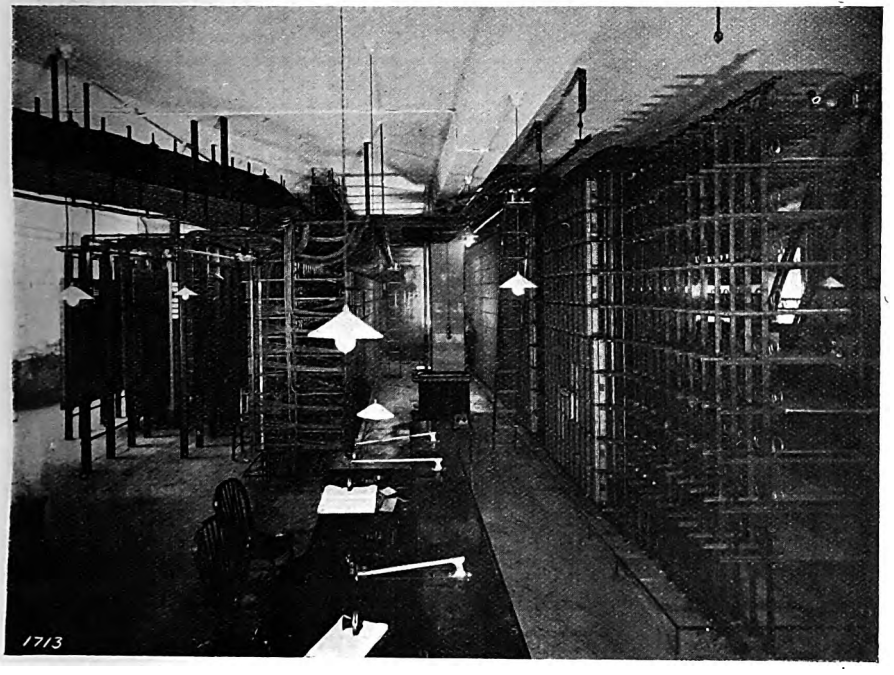
2.—NEW "AVENUE" EXCHANGE.—CABLE CHAMBER.

MAIN DISTRIBUTING FRAME.—One of the most prominent features on the ground floor is the main distributing frame, which extends over the greater part of the room. The frame is 11 ft. high and 46 ft. in length. Channel and angle iron is used in construction, wherever possible, to ensure rigidity. On the line side 970 glass tube fuse mountings, each for 40 fuses, are fitted; on the exchange side each vertical is fitted with arrester bars equipped with heat coils and lightning protectors for 200 circuits. The line verticals have a capacity for 19,800 lines; the apparatus verticals provide for 9000 subscribers and 4800 junction and miscellaneous circuits.

Digitized by Google

INTERMEDIATE DISTRIBUTING FRAME.—Parallel to the main frame are the intermediate distributing frame and the relay and meter racks. The intermediate frame is of the standard type, which has been adopted by the Department, and is strengthened in a similar manner to the main frame by the use of channel and angle iron in construction. Overhead runs are provided for interconnecting cables.

RELAY RACK.—The relay rack has a capacity for 9000 line and cut off relays, and 1200 miscellaneous relays and resistance spools.



3.—NEW "AVENUE" EXCHANGE.—TEST ROOM.

METER RACK.—The meter rack (4) is designed for the ultimate equipment of 9000 lines. 5 shows the meters at a closer range.

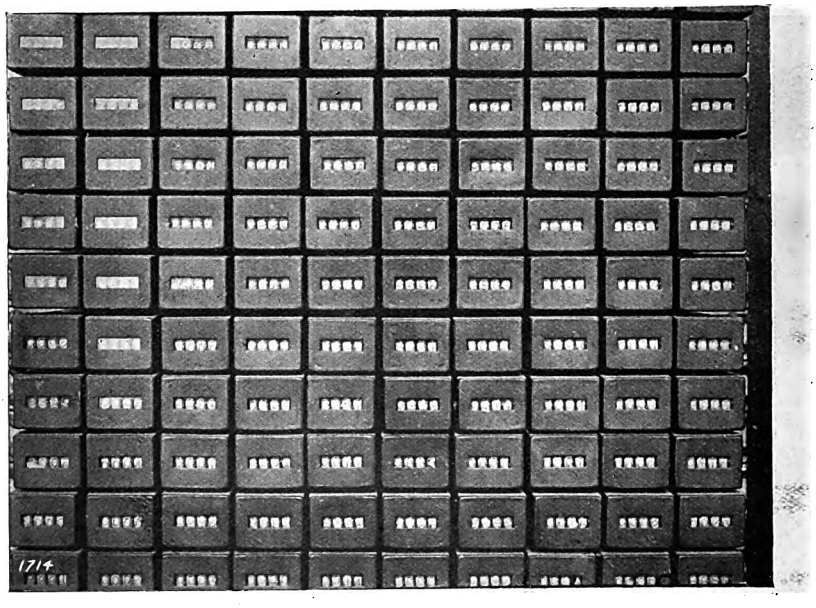
JUNCTION REPEATING COIL AND CONDENSER RACK.—Situate at the east end of the test room is the junction repeating coil and condenser rack with a capacity for 1728 coils and 3456 condensers. Repeating coils are not required for subscribers' connecting cord circuits in the Peel Conner system.

FUSE CABINET.—The fuse cabinet is provided with alarm fuses. Each fuse is equipped with a small block of porcelain fitted on a spring which is kept in position by the fuse wire; when a fuse is blown the porcelain falls forward and indicates the fuse at fault;

Digitized by Google

simultaneously a lamp glows at the head of the particular fuse distribution strip; in addition the alarm bell rings.

TEST AND FAULT CLERK DESKS.—For the localisation of faults and the control of the staff engaged upon outdoor fault and maintenance work a four-position test desk and a two-position fault clerk's desk are installed. Circuits from the test desk to the testing position (6) on the "B" board are provided so that access to any subscriber's circuit can be gained for testing purposes. The desk is also fitted at each position with a combination of keys and a voltmeter for the testing and localising of faults. An artificial cable of forty-six miles of standard cable is provided for transmission tests.



5.—NEW "AVENUE" EXCHANGE.—METERS.

The operations required for this test will be seen from the circuit given in (7).

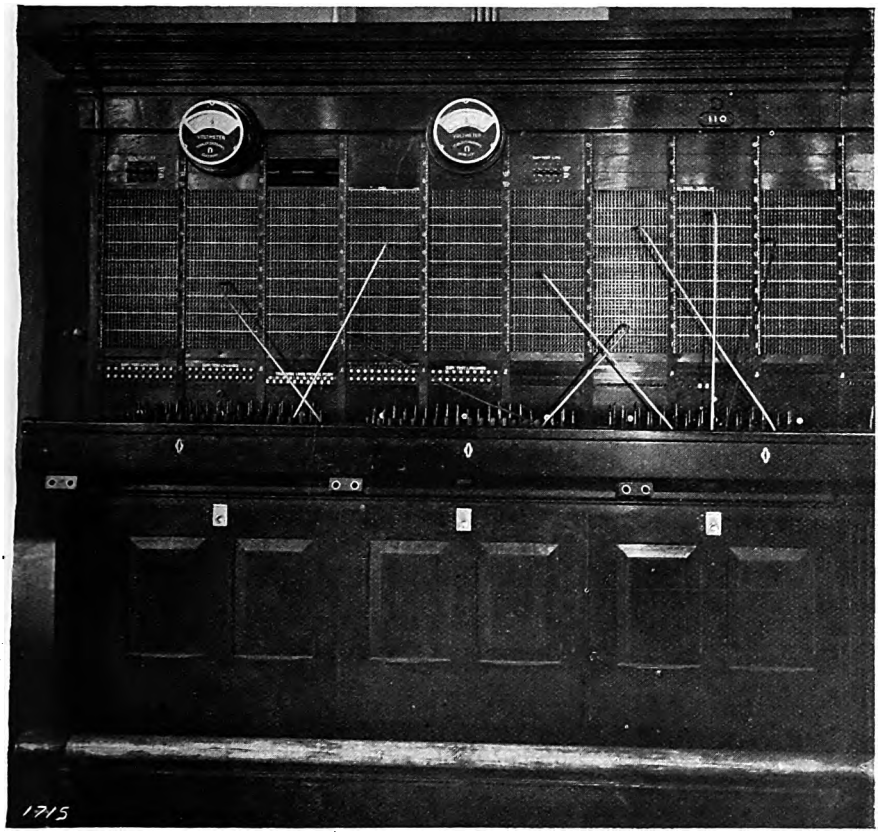
JUNCTION SWITCHROOM.—The incoming junction switchboards are erected on the second floor, the present equipment consisting of fifty-seven positions. Three are wired for trunk purposes, one for electrophone distribution, two for testing and plugging up faulty lines, eight for local transfers, and the remainder for incoming calls from the various types of exchanges in London. With the exception of trunks and a few ringing junctions, the whole of the circuits are arranged for keyless working; the present equipment being 30 circuits per position, with an ultimate capacity for 36 circuits.

INFORMATION DESK.—In the junction switchroom a 12-

Digitized by Google

position information desk is located. This desk is provided with full facilities for conducting the work originally carried out on the inquiry desks which were fitted in earlier exchanges. In addition the official circuits to and from other exchanges are terminated here and means are afforded for intercepting calls on subscribers' circuits.

SUBSCRIBERS' SWITCHROOM.—On the third floor 123 subscribers'



6.—NEW "AVENUE" EXCHANGE.—TESTING POSITIONS AT END OF JUNCTION SWITCHBOARD.

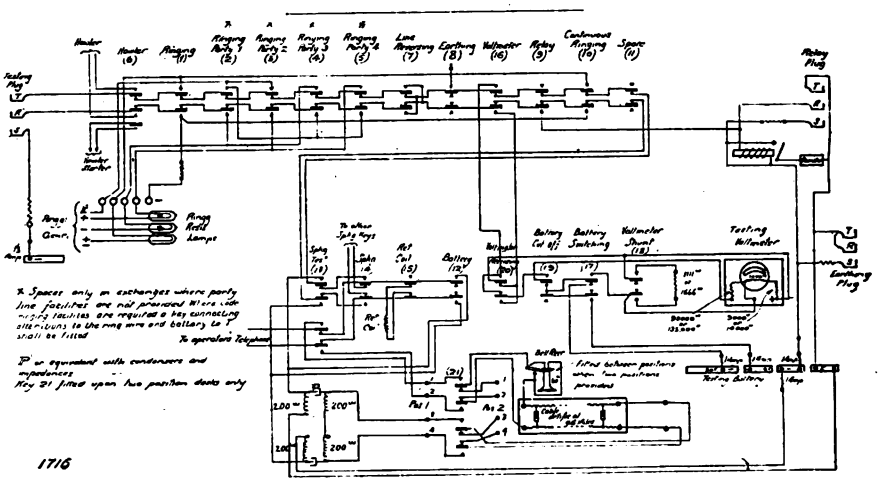
answering positions are fitted. These boards are equipped with apparatus for dealing with all calls originating from subscribers connected to the Avenue Exchange.

In order to understand the method of operating it is necessary to refer to the equipment of both the junction and subscribers' switchboards. The incoming junction sections (8) are fitted with a full multiple of subscribers' lines every nine panels (*i.e.* every section), while no subscribers' multiple is equipped on the answering

Digitized by Google

sections, due to the fact that by far the greater part of the calls made by the Avenue subscribers are for lines connected to other exchanges. In these circumstances and in view of the enormous cost of the extension of the multiple over the subscribers' answering positions, it was decided to adopt the partial multiple system, under which local calls are completed at the junction switchboard by means of keyless transfer circuits. These transfer circuits are multipled on the outgoing junction field on the answering positions, and are terminated at the "B" board in a similar manner to the incoming junctions from other exchanges. The connections are established by means of order wires from the "A" board.

ANCILLARY WORKING.—One of the most interesting departures on the "A" board, known as the ancillary system, is the arrangement



7.—NEW "AVENUE" EXCHANGE.—TESTING CIRCUIT (TEST DESK).

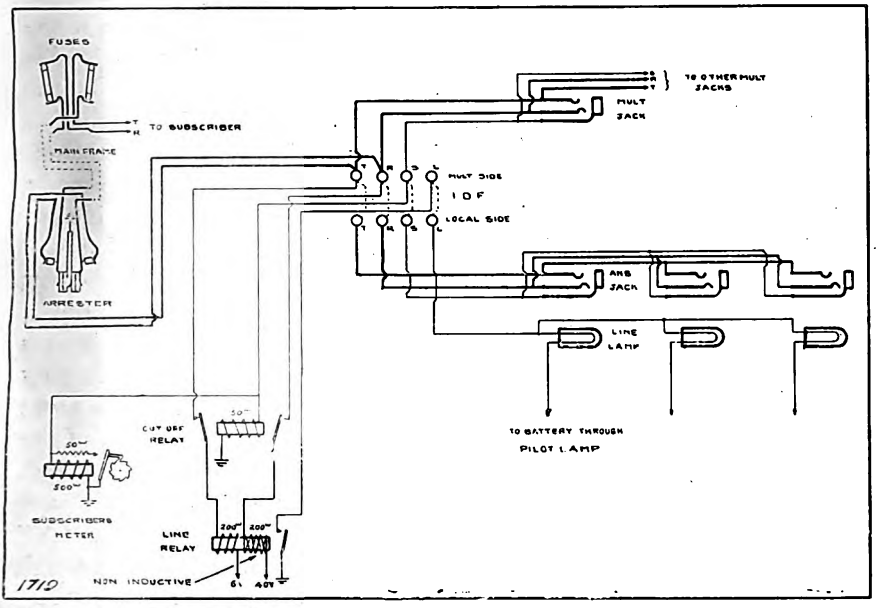
of the subscribers' calling circuit. On answering positions at exchanges not provided with ancillary jacks only three operators have direct access to a given call, namely, the operator on whose position the call originates, the adjacent operator on the right, and the adjacent operator on the left. It is the aim of the ancillary system to increase the size of this group of operators by bringing the call within the reach of more. This is attained by multiplying the answering jack and lamp twice so that each appears on three different positions of the switchboard. One of the three jacks may be described as the primary jack, and the others as ancillary jacks. The total of 123 subscribers' positions is made up of three groups, each of 41 positions, and every subscriber's circuit has an answering jack and lamp in each group. The primary jacks and lamps are arranged at the bottom of the panels, and the ancillaries immediately

Digitized by Google

Digitized by Google

Digitized by Google

above them (9). The primary jacks and lamps in the first group appear as ancillaries in the second and third groups, the primaries of the second group as ancillaries in the first and third groups, and the primaries of the third group as ancillaries in the first and second groups. Under this system of working the "A" operators have direct access to nine groups of local jacks, and the group of operators having access to each call is increased from three to nine. From the foregoing it will be seen that the ancillary system tends to make the whole exchange one team and promotes uniformity of traffic pressure. The method is also useful for concentration at night time and during periods of light load, as the whole of the subscribers' calls



10.—NEW "AVENUE" EXCHANGE.—SUBSCRIBERS' LINE CIRCUIT WITH ANCILLARY JACKS.

can be dealt with in one group of 41 positions. A subscriber's line-circuit equipped for ancillary working is shown in **10.**

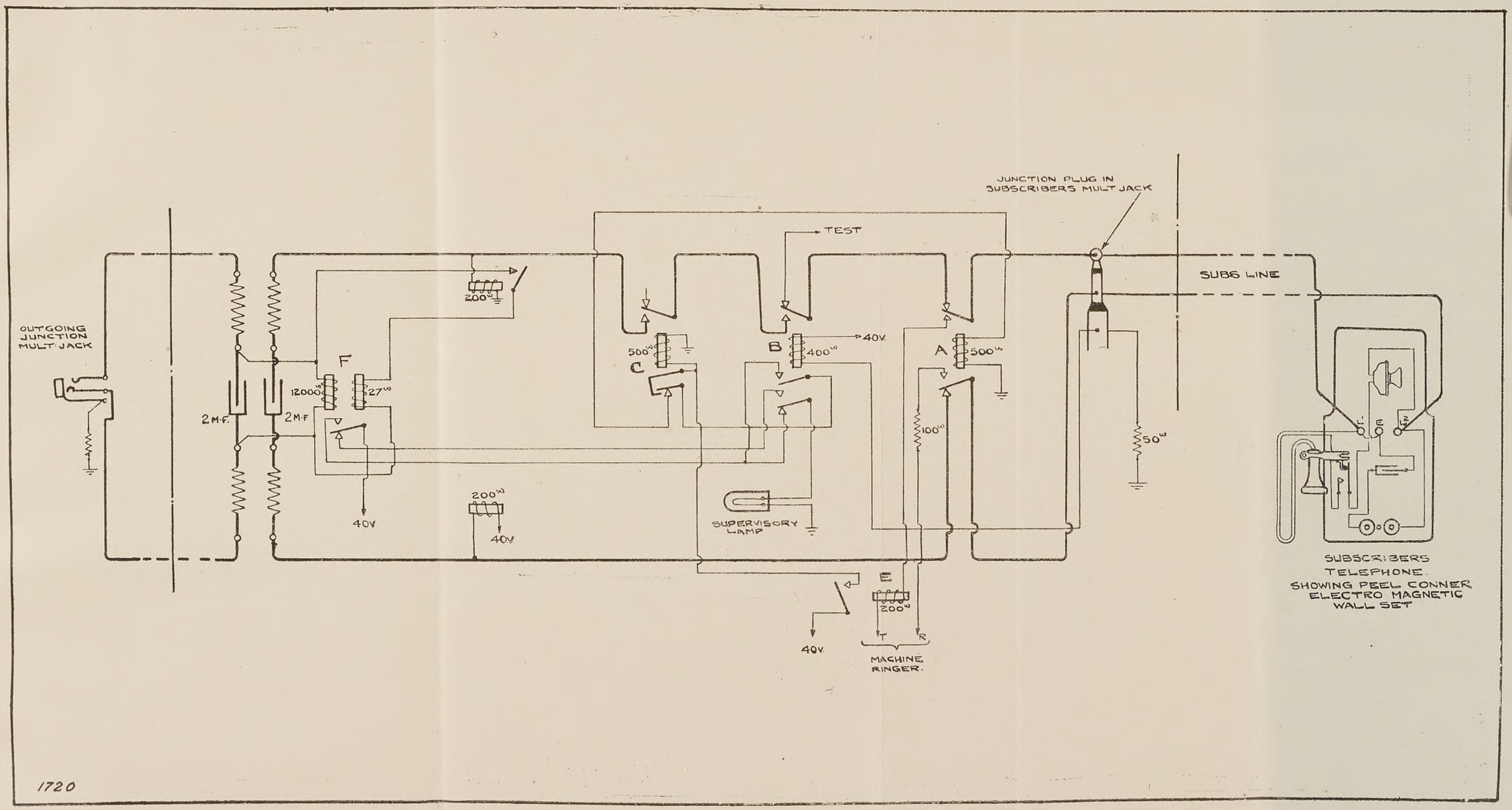
The method of dealing with a local connection is briefly as follows: The lifting of the receiver at the subscriber's instrument causes the calling lamps to be lighted at the "A" board. The disengaged operator at one of the three groups inserts an answering plug into the subscriber's answering jack and ascertains the number required. This number is passed on an outgoing order wire to the "B" operator on the incoming transfer position, who allocates a disengaged transfer circuit; at the same time she takes up the plug of the circuit allocated and tests the called line; if this is not in use the connection is made. The keyless ringing mechanism is set into

Digitized by Google

operation, and the called subscriber's bell rings until the receiver is taken off the switchhook. In the meantime the operator who handled the call at the "A" position completes the connection by inserting the calling plug into the jack on the outgoing junction multiple of the transfer circuit quoted. The clearing signals on the termination of the conversation are received at the "A" board; the operator then presses the meter key to register the call and afterwards the plugs are withdrawn. The withdrawal of the plugs at the "A" position causes a clearing signal to be given at the "B" position, where the circuits are restored to normal.

INCOMING KEYLESS JUNCTION CIRCUITS.—As in other London exchanges, the calls between subscribers in different exchanges constitute the major portion of the traffic, and rapid and accurate working of junctions becomes a most important factor. A considerable saving of time in operating the junction circuits is effected by the use of keyless ringing circuits. This method of working junction circuits expedites the speed of connecting, and admits of more junctions being worked from one position than was obtained formerly with machine-ringing keys. The circuit of a keyless junction incoming from a C.B. exchange is shown in **11**. The operation is as follows: The request from a distant exchange for a connection is given over the order wire. The "B" operator at the Avenue Exchange allots a disengaged junction circuit, and the distant "A" operator inserts the calling plug of the pair in use into the corresponding outgoing junction jack of the same circuit. The Avenue operator at the same time inserts the incoming junction plug into the multiple jack of the required subscriber's line after proving the circuit to be disengaged. Through the insertion of the plugs relays "B" and "F" are operated, thus closing the circuit through the winding of relay "A" and so allowing the ringing current to pass out to line through relay "E." It will be noted that the ringing control relay "A" cannot be operated until relay "F" is actuated. This is arranged to prevent false ringing on the subscriber's circuit should the wrong junction be taken up by the operator at the outgoing end. Upon the subscriber removing his receiver from the switch-hook the 1000$^{\omega}$ bell and condenser on his instrument are shunted by the transmitter and the 17$^{\omega}$ winding of the induction coil, and relay "E" is operated during the ringing period by the generator current, and during the non-ringing period by the battery current. Relay "E" in turn operates relay "C," which locks until the plug is withdrawn at either end of the circuit. The actuation of relay "C" opens the circuit through relay "A," which is de-energised, and the ringing current is removed from the line and speaking conditions follow. The supervision of the conversation is maintained from the originating end, and should it be necessary to ring the called subscriber again,

Digitized by Google



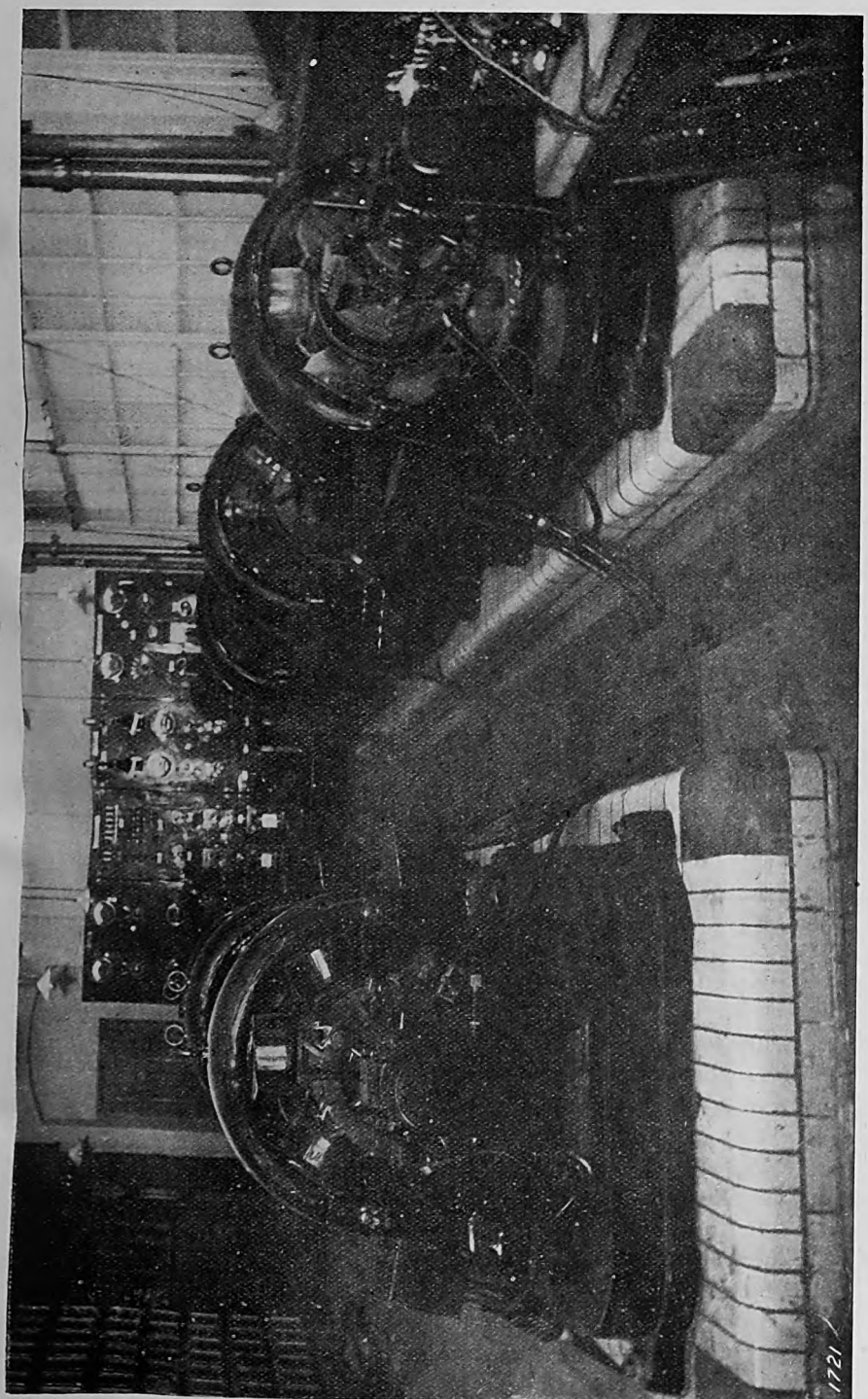
II.—New "Avenue" Exchange.—Incoming C.B. Junction from C.B. Keyless Ringing (O.W. Working.)

Digitized by Google

operati
taken
handle
insertii
multip
termin
operat
wards
the "
positio

INC
exchan
stitute
ing of j
saving
use of
circuits
tions b
with m
ing fro
The rec
the ord
disenga
the call
junctio
time in
require
Throug
operate
and so
relay "
cannot
prevent
junctio
subscri
and co
and th
operate
during
in turn
at eithe
circuit
current
The sup
end, an

Digitized by Google



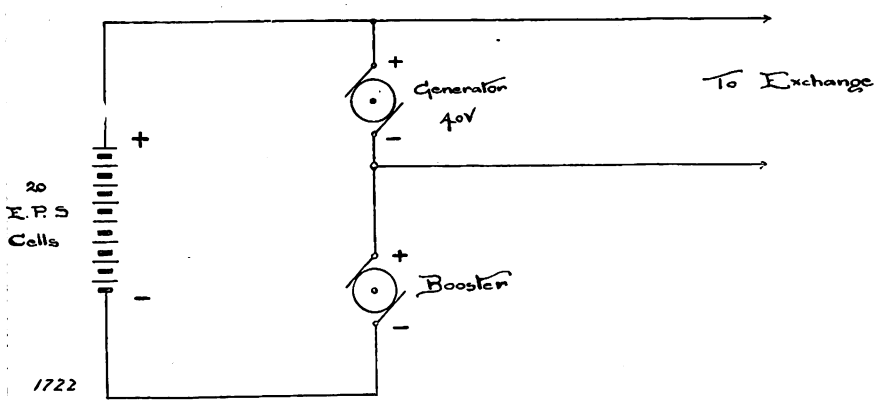
12.—New "Avenue" Exchange.—Charging Machines.

Digitized by Google

owing to his having left the telephone (with receiver restored), the distant operator has only to withdraw the plug from the jack and re-insert it when the ringing will be re-started. The clearing signal to the Avenue operator is given by the restoration to normal at the outgoing end.

The circuit described and shown in **11** is arranged for order wire working from a C.B. exchange, and illustrates a typical junction. The same principle of keyless working is applied to junctions from magneto and C.B.S. exchanges (whether arranged for order wire working or for signalling junctions), in which cases, of course, the circuits are designed to meet the particular requirements.

POWER PLANT.—Duplicate motor-generator booster sets (**12**)



13.—NEW "AVENUE" EXCHANGE.—BOOSTER CIRCUIT; EXPLANATORY DIAGRAM.

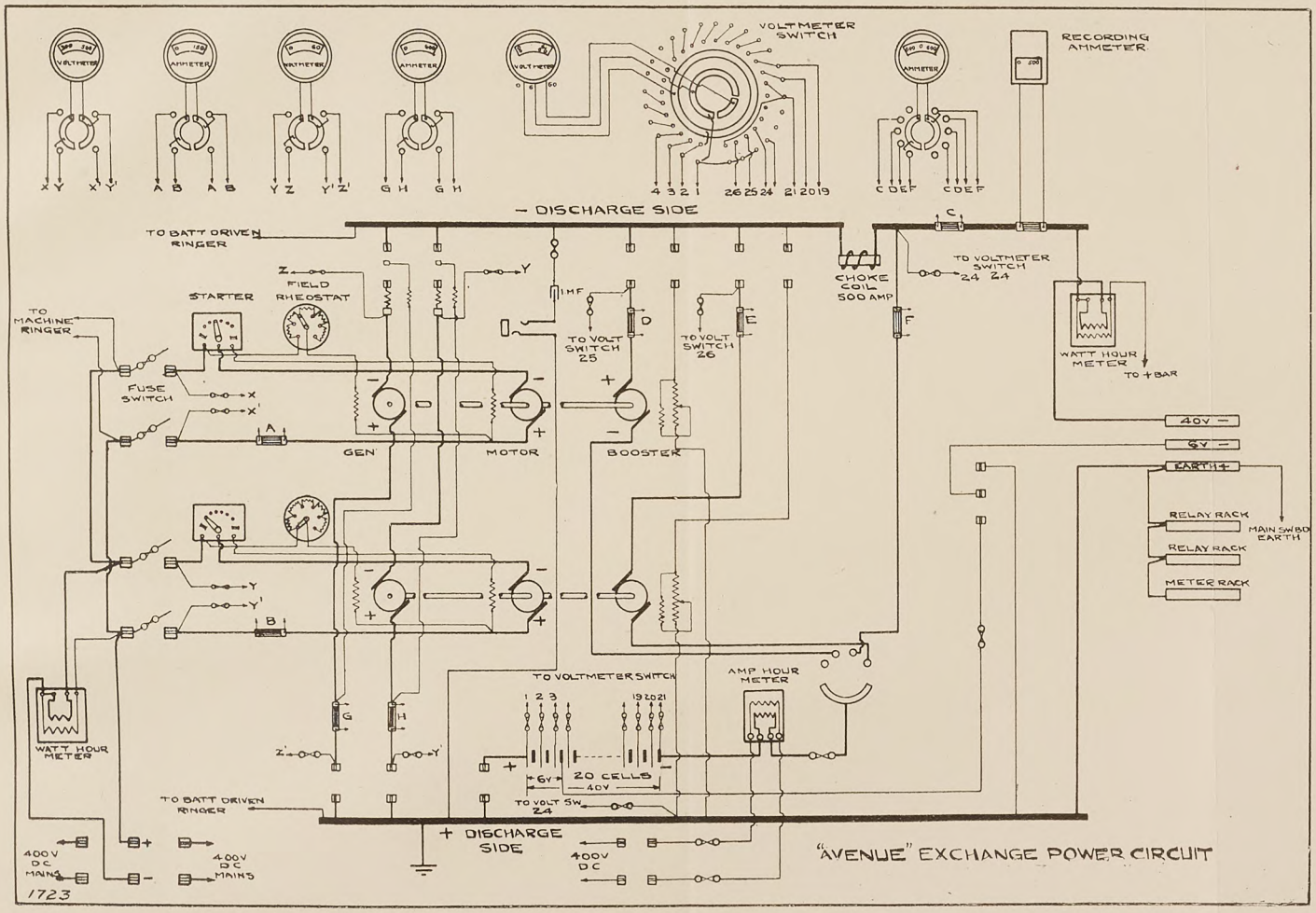
are provided, and so arranged that the generator delivers current at a constant pressure to the exchange, while the additional voltage necessary for the charging of the secondary cells is provided by the booster, which is switched into circuit when the battery is being charged (**13**). In this way the exchange is assured of a supply of current at a constant voltage.

Two belt-driven motor generator sets are provided for ringing purposes and for operating the interrupters required for the ringing and tone test arrangements.

The battery is placed in the basement immediately below the power plant. Twenty E.P.S. cells are used, having a capacity for a maximum discharge of 2,800 ampère-hours at a nine-hour rate.

Careful provision has been made for the recording and checking of energy consumption. The supply taken from the 400 volt D.C.

Digitized by Google



14.—New "Avenue" Exchange.—Power Circuit Connections.

TEI

ow
dis
ins
to
out

wo
sat
ma
wc
cir

20
E.F.
Cell

/.

ar
a
ne
bc
cl
cu

p
ai

p
a

o

2

Digitized by Google

main is recorded on a supply meter; the energy delivered to the exchange by the generator and cells combined is measured by a Watt-hour meter; and a double-dial ampère-hour meter registers both the current taken by the accumulators when under charge and the output of the cells when being discharged. The power circuit is shown in 14.

The whole of the equipment is of British manufacture, and has been installed in the exceptionally short time of six months by the Peel Conner Telephone Works, Ltd., Peel Works, Manchester, to whom the writer is indebted for the use of the photographs reproduced in this article. The reader who desires further details of the 40-volt C.B. working is referred to Mr. J. W. Turner's excellent contribution on the Glasgow Telephone Exchange, which appeared in vol. 2, part 4* of this JOURNAL in January, 1910.

P.B.X. CORDLESS SWITCHBOARDS WITH AUTOMATIC DISCONNECTION.

By W. AITKEN, M.I.E.E.

THE Automatic Telephone Manufacturing Co., Ltd., have devised a form of cordless switchboard having automatic disconnecting facilities, for use in connection with the existing manual systems.

These switchboards have some novel features, and mark a decided departure in design and methods of operating for small branch exchanges where there is no regular attendant. It is claimed for them that they are practically "foolproof." The attendant has simply to make the connection to the line required, when all responsibility ceases, the remaining operations being entirely automatic. By the depression of the switch to make connection, the holding-coil is automatically cut off. By the act of answering an exchange call the indicator is automatically restored, and, after the conversation is complete, the connection is automatically severed when the telephones are replaced, and all apparatus restored to the normal or calling condition. Similarly, when the attendant replaces the receiver, the service switch, the exchange line, and any apparatus that may be in use by the attendant are automatically disconnected and restored to the normal.

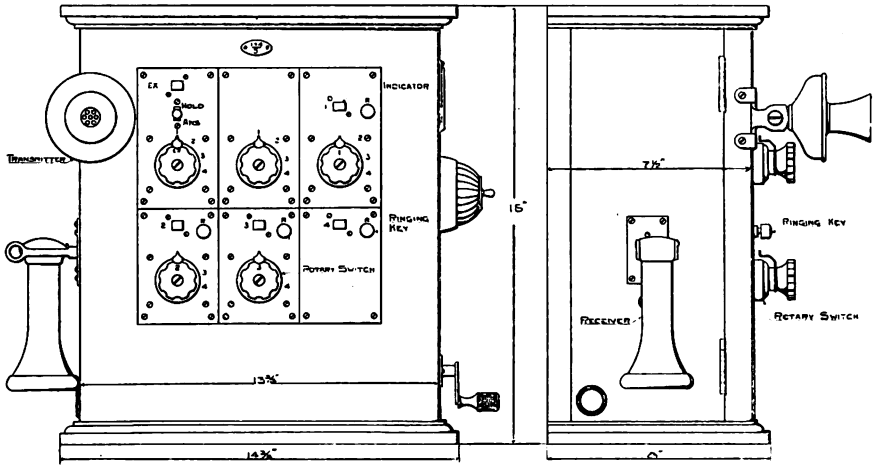
When the receiver at the extension instrument (line 1, line 2, etc.) is replaced, the connection is automatically disconnected at the private branch board and the clearing signal instantaneously given

* A few copies of this special number are still available, and may be had at 2s. each, post free.

Digitized by Google

to the "Central" operator. On small switchboards this is very important, and is a very valuable feature. At present when there is no regular attendant there may be delay in giving effect to the clearing signal at the private branch board, and if the line is immediately cleared at the central exchange and another call is sent in over the exchange line, the extension instrument lately connected will be again called instead of the branch operator, or should the extension station, after clearing to the central, desire another connection on the branch exchange board, a call will be sent in to the central operator who is not wanted.

A multiple contact rotary switch (3) is associated with each line, and, when rotated till the pointer is over the number required and



1.—$\frac{1+4}{5}$ AUTOMATIC DISCONNECTING CORDLESS SWITCHBOARD.

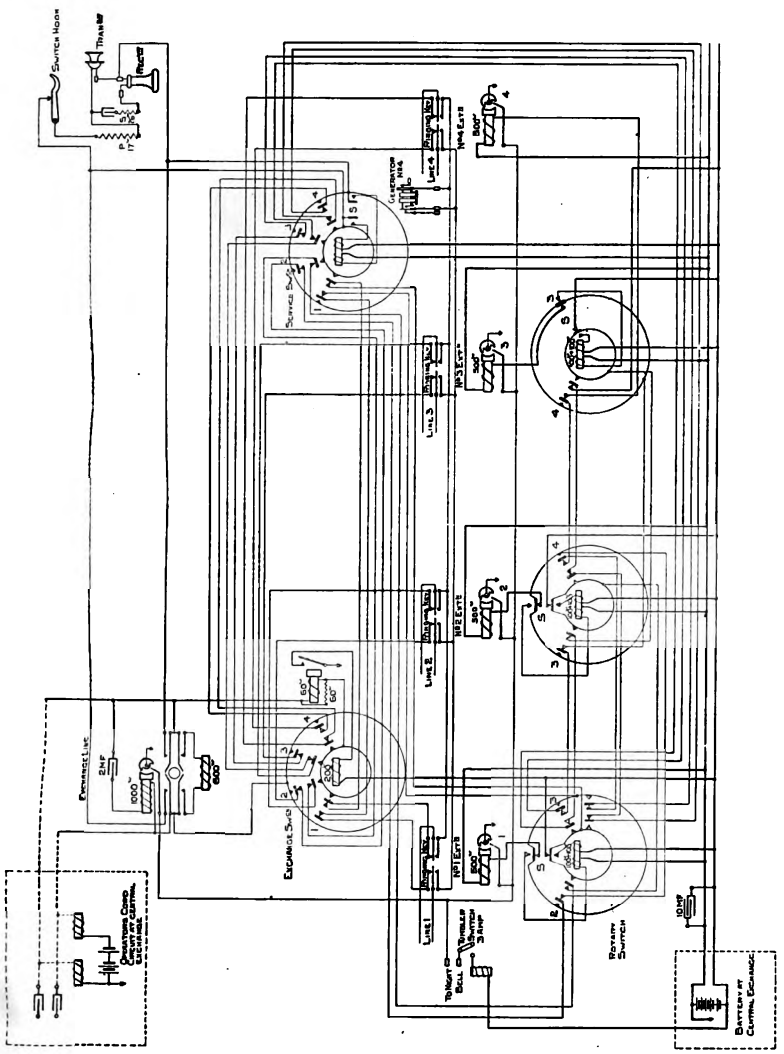
depressed, it connects the two lines together. The switch is electro-magnetically retained as long as current is flowing in the line circuit.

A multiple arrangement of connections is used. On a 1 + 4 line board the exchange and service rotary switches each have four groups of springs (2) associated with lines Nos. 1, 2, 3 and 4 respectively to give connection between the exchange and any of these lines. No. 1 line switch has groups 2, 3, 4 giving connection between No. 1 line and any of these numbers. No. 2 switch has groups 3, 4, giving connection between No. 2 and any of these numbers. No. 3 switch has group 4 for connection between lines 3 and 4. The service switch is used for answering or calling any extension line.

The rotary switch is provided with an electro-magnet fitted centrally in an iron tube (3), around which the groups of line springs

Digitized by Google

are fitted (an extra switching group being operated every time the plunger is depressed to cut off the calling indicator). The plunger is provided with an armature, so that when it is depressed to operate a group of springs, the armature completes the magnetic circuit of



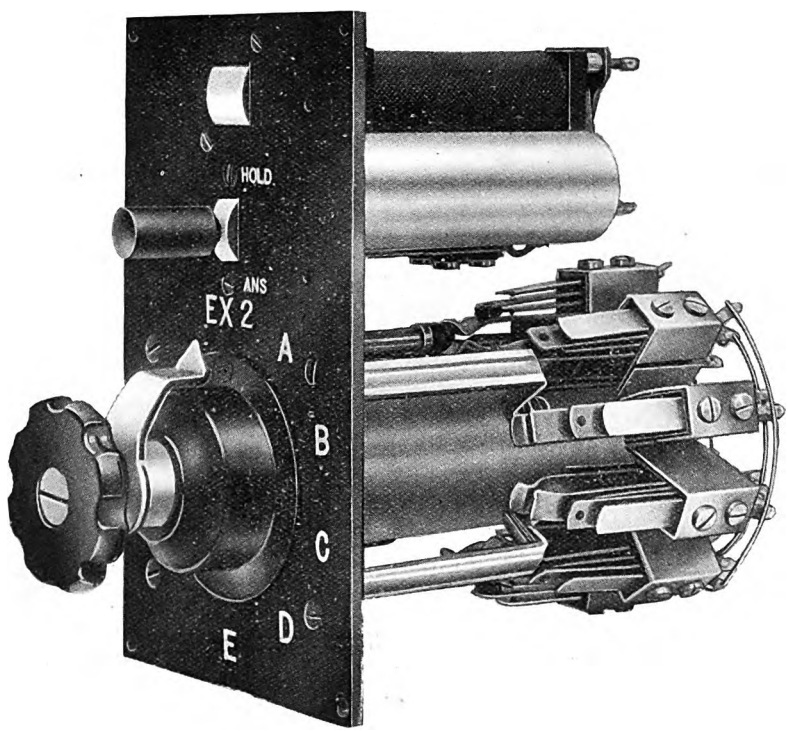
2.—Connections of $\frac{1+4}{5}$ Automatic Disconnecting Cordless Switchboard.

the coil through which current is supplied to energise the microphones, so that the plunger remains down and the connection completed as long as current circulates through the winding. When the receivers at the sub-stations are replaced after a conversation, and the battery circuit, therefore, opened, the electro-magnet is de-energised and allows the apparatus to return to the normal condition.

Digitized by Google

The extension line indicators are of the gravity type, and are of 500 ohms resistance, single wound.

The exchange rotary switch is provided with make and break contacts (see **2**), so as to cut off the indicator of the called line, as current to energise the microphone is supplied over the exchange circuit when a connection is made between an extension line and the public exchange. In addition to the rotary switch a two-way switch is provided (**3**) for the exchange line, and the downward



3.—Exchange Line Switch Unit on Multiple Pattern Switchboard.

position of the lever connects the exchange line with the attendant's telephone, and also restores automatically the line-indicator, which is of the magneto-drum type and connected across the exchange line with a condenser in series. When the lever is in the "up" position a holding coil is connected across the exchange line to avoid giving a clearing signal to the central operator whilst the attendant is calling the station wanted. The holding coil lever is linked up to the rotary switch in such a way that when the plunger is manipulated to connect the exchange line with the extension the holding-coil key is automatically restored to the normal position.

Digitized by Google

This is a very valuable feature, as on all other switchboards it is necessary for the attendant to manually put the holding coil to the "off" position, and this is frequently omitted to be done, to the detriment of transmission efficiency.

In the speaking position of the two-way switch, the attendant's telephone is connected directly to the exchange line, so that it is energised by current from the central exchange. When, however, the attendant's telephone is used in connection with an extension line, current is supplied to energise both microphones over the feeder lines from the central exchange or from a local battery.

A ringing key is associated with each extension line. Instead of the attendant connecting with the line wanted by manipulating the service switch, he may simply press the ringing key and wait until the line-indicator indicates, by showing white, that the wanted station has answered, and the attendant can then complete the connection, or may have previously completed the connection before ringing.

When an extension is through to the central exchange, the caller, having completed one call, is able to get another or several calls through the central without the intervention of the branch exchange operator. This result is obtained by connecting in the exchange circuit a slow-acting relay (60^{ω}), having in parallel with it a non-inductive shunt of 60^{ω} to prevent distortion of the speech waves. The retaining coil (200^{ω}) of the rotary switch is connected to a battery in a local circuit of this relay.

The relay is of special design, having a mass of copper at one end of the core, which makes it very sluggish. When, therefore, the subscriber at the extension desiring a second connection with the central exchange moves the switch hook up and down in the well-known manner, the relay has not time to de-energise during the short breaks, and consequently the rotary switch is not released. When, however, a prolonged break is made, as when the receiver is replaced, the relay acts and gives automatic disconnection at the branch exchange, and the clearing signal to the central operator.

The operating is as follows:

CENTRAL EXCHANGE TO P.B.X. SUBSCRIBER.—When the line indicator operates, the attendant moves the two-way switch to position "ans. exch." (2) and speaks. If No. 4 station is required, the two-way key is moved to position "hold," whilst the attendant calls No. 4 by service switch. Ringing-key 4 is pressed and generator turned. The attendant may speak, or, when the No. 4 line indicator operates, the exchange rotary switch is revolved to position 4 and pressed. The holding coil key is thereby automatically thrown to normal.

Station No. 4 by replacing the receiver restores the rotary switch

Digitized by Google

(which brings all apparatus to normal) and gives the clearing signal to central.

P.B.X. SUBSCRIBER CALLING CENTRAL SUBSCRIBER. — The attendant ascertains requirements by depressing service switch over the number calling, then releases service switch by momentarily depressing the switchhook and moves two-way switch to "ans. exch." position and passes call to central operator. The exchange rotary switch is revolved and depressed to number calling; or, on hearing that the exchange is wanted, moves exchange rotary switch to number of line calling and allows caller to hand in his call.

P.B.X. EXTENSION TO EXTENSION.—Say No. 1 calls No. 4, line-indicator No. 1 operates; attendant revolves and depresses service-key to No. 1 position and ascertains the requirements. Ringing-key 4 is depressed and station called by generator. Operator releases service switch and revolves No. 1 rotary switch to position 4 and depresses; the call is then through. The rotary switch is restored when both stations replace their receivers.

Switchboards similarly arranged to the 1 + 4 are proposed for various sizes up to 2 + 6 lines, and the manufacturers believe that the reliability of operation will recommend them for larger sizes.

For switchboards of a larger capacity than 2 + 6 lines a rotary switch is also associated with each line. The groups of springs surrounding the tube of the switches are now wired in parallel and used as connector circuits. These connectors are the equivalent of cord circuits on the ordinary switchboards, *e.g.* No. 2 group of springs on each switch will be connected in parallel and be insulated on each switch. The inner springs or ring-conductors of the connector groups are connected to the line with which the switch is associated, so that when two switches are manipulated to make contact with corresponding groups it will be seen that these are joined together by the connector circuit, and that the two line-indicators are cut out of circuit and the two retaining electro-magnets connected across the lines by the special groups of springs. No service switch is provided, and each rotary switch has an answering position.

SUTTON NEW EQUIPMENT.

THE original Post Office Exchange at Sutton was installed in 1905. It had nominally a capacity of 600 subscribers, but last year 200 further lines were crowded in to accommodate the urgent needs of the area. The switchboard was of the No. 9 type, with a 36-volt battery, bulls-eye indicators, and all the apparatus mounted at the rear of the board. No I.D.F. or meter racks were used.

Digitized by Google

During last autumn the installation, by the Western Electric Co., of a complete No. 10 equipment was provided, and the change-over was effected on November 18th last. The new boards have an equipment of 1000 lines, but the ultimate capacity is 2000 lines.

It was necessary to enlarge the old switchroom to almost double its former size by the demolition of a party wall, dividing it from the old test-room. The work necessitated the shifting of the existing switch sections and the main distributing frame without interfering with the working conditions. This was managed without trouble, but with a good deal of unavoidable inconvenience, both to the engineering and the operating staffs.

The No. 10 board has lamp signalling, and is so far as operating conditions are concerned practically identical with the No. 1 type. More apparatus is, however, accommodated at the rear of the sections than in the latter type of board.

A point of interest is that the cables to the line and cut-off relays are taken from the vertical side of the I.D.F., and do not thus retain their regular consecutive order when lines are cross-connected. They are therefore marked, not with the subscriber's number, but with the panel and lamp number. The meters are taken as usual from the horizontal side, and do not change their position on the racks with cross-connections.

An operator's testing position is provided as well as an up-to-date test desk equipment.

The old power plant has, with the exception of one machine, been superseded by new plant. There are two charging motor generators, two ringing machines, together with a complete new power board.

The new test-room being in a different position of the building, it was necessary to arrange a new entrance for the street cables. A T-joint was made on each of the existing cables at a convenient point, and after the change-over was made, the length to the old main frame was cut away, and the stump sealed after the wires had been carefully insulated.

The actual change was carried out with complete success.

W. A.

TELEPHONE TRANSMISSION.

By F. Addey, B.Sc.

The subject of the theory of the transmission of telephonic speech currents is one of daily increasing importance, and it is highly desirable that a knowledge of its elements should be possessed by every engineer whose duties bring him into contact with telephone questions, even though he may not be concerned with problems calling for profound theoretical knowledge.

The subject is not really abstruse, but as it is investigated by means of mathematical processes which are not yet very widely

Digitized by Google

known, the student is apt to be repelled by the first contact with a branch of his profession which, on further acquaintance, will be found to be one of the most fascinating in the whole range of applied electricity.

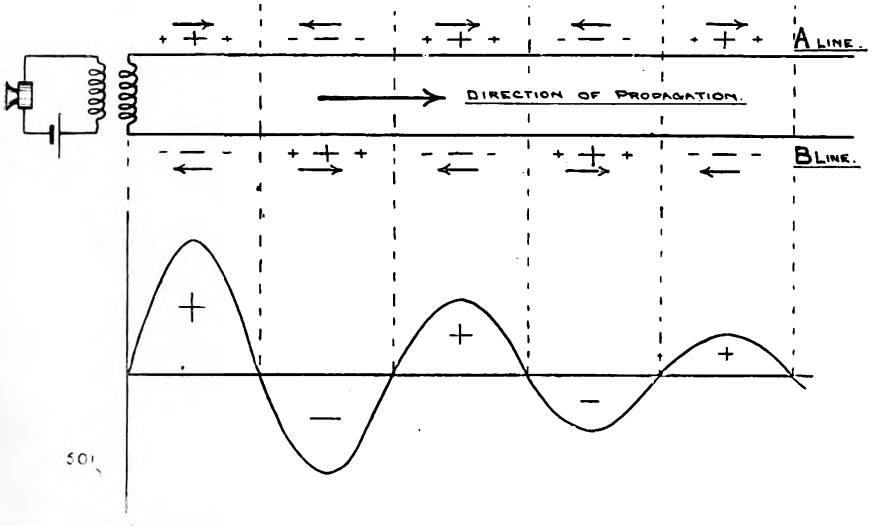
The papers given by Messrs. J. G. Hill, November 12th, 1906, and A. W. Martin, January 11th, 1909, before the Metropolitan Centre of the Institution of Post Office Electrical Engineers, the paper by Mr. A. G. Lee, January 11th, 1909, before the Newcastle Section of the Institution of Post Office Electrical Engineers, and the article by Mr. A. G. Lee published in this Journal (vol. 3, 1910, p. 238), have already dealt with certain branches of the subject. The matter is so important, however, that I do not think any apology necessary for an article which, although up to a certain point, must necessarily cover ground previously dealt with in the contributions mentioned, yet, I venture to think, deals with these matters in a somewhat different manner; and in addition, discusses a branch of the subject, that of the application of hyperbolic functions to the theory of telephone transmission, which has not yet been at all fully dealt with in any Post Office publication.

I propose to divide the article into four sections. In the first section the phenomena which occur in a telephone circuit will be described. A knowledge of these phenomena has not only been obtained by mathematical reasoning, but they can be investigated quite apart from theoretical considerations by means of suitable measuring instruments. It will be found exceedingly helpful, in approaching the mathematical side of the question, to have a clear idea of the actual phenomena to be dealt with, even though, for the time being, such knowledge has to be taken on trust. Otherwise it is only after wading through much apparently irrelevant and in itself rather uninteresting matter that the student realises whither his studies are tending. The second section will deal with the mathematical methods used in these investigations, and in the third section these methods will be applied to the solution of the more important problems which occur in telephone practice. In the final section descriptions will be given of some methods of measurement, by which the results obtained in the third section can be actually verified.

THE PHYSICAL PHENOMENA IN TELEPHONE CIRCUITS.—It is well known that sound is caused by waves of compression and rarefaction which are formed in the air by the vibrations of the sounding body. In striking the diaphragm of a telephone transmitter alternating currents are set up in the line, the wave form of which corresponds to that of the incident sound-waves. This form is, in general, very complex. It has, however, been shown by Fourier that a periodic wave, of no matter how complex a form, can be

Digitized by Google

resolved into a number of simple harmonic waves of different length. A simple harmonic function is one which follows a law of the form $y = a \sin px$, where y is the quantity which varies harmonically as x increases. The ease with which a telephone circuit will transmit a simple harmonic alternating current is found to depend on the frequency. Each component of the complex wave impressed on the circuit is transmitted as if it alone were present, but the shorter waves suffer greater loss in transmission than the longer waves. Consequently at the receiving end, where the movement of the telephone diaphragm and consequently the sound emitted depend on the shape of the resultant current wave received, which resultant wave is the sum of the component waves, it follows that the received sound-waves will not be the same as those at the sending end,



1.—Distribution of Currents and Charges over a Telephone Circuit.

because the relative magnitudes of the components of the waves will be no longer the same.

We can investigate the transmission of sound over a telephone circuit by analysing the impressed wave into its simple harmonic components, tracing each of these components separately through the circuit, and then recombining the component waves at the receiving end to get the actual received wave. The problem, therefore, resolves itself into a discussion of the propagation of a simple harmonic alternating current along the circuit.

Consider the telephone circuit shown in 1. If a simple harmonic sound wave impinge on the diaphragm of the transmitter a simple harmonic electro-motive force will be thereby applied to the ends of the line. When this electro-motive force is in one direction

Digitized by Google

a positive charge will be sent into, say, the A line, and a negative charge will be sent into the B line. These charges slide away down the lines. Now a moving charge of electricity constitutes a current. A positive charge in motion corresponds to a current flowing in the direction in which the charge is moving, while a negative charge in motion corresponds to a current in the opposite direction to the motion of the charge. Hence these charges sliding down the wires constitute currents of electricity, in opposite directions in the two wires, as shown by the small arrows. These currents do not flow round the whole circuit, but are confined at any instant to the small portion of the circuit along which the charge, the motion of which constitutes the current, is spread at that instant. However, as the charges slide down the wires, these currents occupy successively different sections of the circuit.

Following the pulse of electro-motive force we have just considered, another occurs in the opposite direction. This reverse pulse sends a positive charge into the B line, and a negative charge into the A line, and these charges slide away down the lines as before.

Thus, during the time that the transmitter is receiving the sound, a succession of alternately positive and negative charges of electricity will be sent into each line, the shape of the curve representing the distribution of any one of these charges depending on the nature of the note being received. As these charges slide along the wires, they become smaller due to losses which occur in the line. We may therefore form a mental picture of the line transmitting a simple harmonic wave as shown in the second diagram of 1, where the curve represents the distribution of the charges over the A line at a particular instant. Along the B line the shape of the corresponding curve would be exactly the same, but positive charges on the A line would correspond to negative charges on the B line and *vice versâ*.

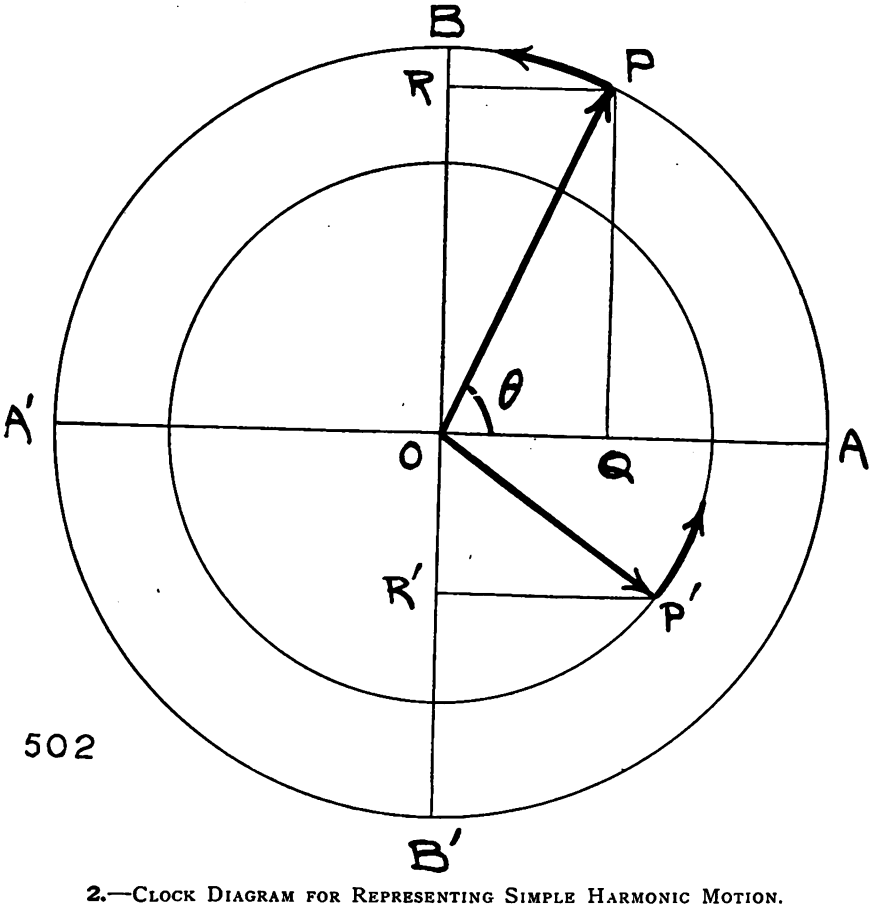
Since the current at any instant at a particular point due to these moving charges depends only on the magnitude of the charge there at that instant, because the velocity at which the charges slide down the wires is constant, it follows that we may consider the curve shown in the second part of 1 as representing the distribution of current in the A line.

If we fix our attention on any one point of one of the wires, the current at that point will rise and fall harmonically, with the same frequency as that of the incident sound, but the amplitude of the variation will decrease as we consider points further and further from the sending end of the line. Also, if we fix our attention on, say, the maximum of any particular pulse, and follow it as it slides down the line, it is evident that the maximum values at successive points along the line, due to the particular pulse under consideration, will

Digitized by Google

occur later and later, as the pulse reaches points further and further along the line. That is, the phase of the simple harmonic variation at any point on the line lags behind that of any other point situated nearer the sending end.

We may represent a simple harmonic variation by means of the well-known crank diagram (2). An arm of constant length OP is supposed to rotate steadily in an anti-clockwise direction about the



2.—Clock Diagram for Representing Simple Harmonic Motion.

centre O. Then the length of the perpendicular PQ at any instant is given by the equation $PQ = OP \sin \theta$, where θ is the angle POA.

The projection OR of the radius OP on the diameter BOB' is also equal to $OP \sin \theta$. Thus, as the arm rotates, the point R moves harmonically up and down the diameter BOB'.

If our crank turn at a speed of n complete revolutions per second, in t seconds it will have turned through an angle of $2\pi nt$ radians. Hence, at any time, t seconds after the time when θ was zero, we

Digitized by Google

shall have $\theta = 2\pi nt$, and therefore the length of OR will be $OR = OP \sin 2\pi nt$. As the expression $2\pi n$ is of very frequent occurrence it is for convenience usually denoted by the single letter p. Hence we get $OR = OP \sin pt$.

Suppose now we have another arm OP' rotating about the centre O with the same frequency n, but placed at some angle $P'OP$ behind the arm OP. Also let OP' be less than OP. Then the projection OR' will vary in exactly the same manner as OR except that the amplitude of the variation will be less, and also, that any particular phase of the variation of OR' will occur at a definite time interval after the corresponding phase of OR.

Hence we may draw a clock diagram to represent the current at any point in the line by taking a radius equal in length to the maximum value of the current at that point, causing it to rotate with the frequency of the sound we are considering, but setting it behind the corresponding radius for the sending end of the line by an angle depending on the distance of the point we are considering from the sending end.

Thus if, in **2**, OP represent the maximum value of the current at the beginning of the circuit, then OP' will represent, in phase relative to the maximum current at the sending end and in magnitude, the maximum value of the current at some point along the circuit.

The radius of the clock diagram representing the current at any point is called the vector current at that point. If the magnitude of the vector current be C, and if c be the instantaneous value of the current at any time t we have therefore

$$c = C \sin pt.$$

We have therefore a series of waves of current passing along the circuit from the sending end, getting smaller and smaller as they travel. At any particular point in the circuit the passage of these waves causes the current to vary harmonically, the phase of the variation at any point lagging behind that of the variation at the sending end by an amount proportional to the distance of the point along the circuit.

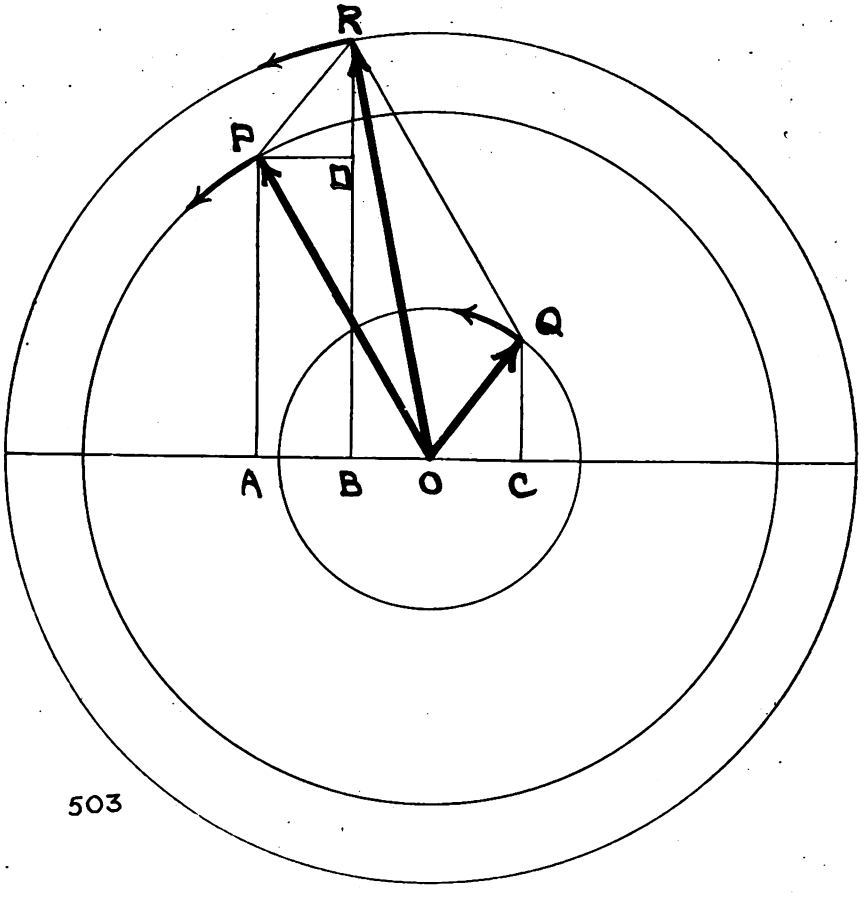
When these waves run up against the receiving instrument, or against a section of line of different type to that at the sending end, reflection may occur. In this case waves will be set up at the point of reflection, and pass back towards the sending end, suffering attenuation as they go. The current at any point will now be the sum of the currents due to the oncoming waves and the reflected waves.

We may of course represent the instantaneous value of the current at any point due to the reflected wave by means of a clock diagram. Let OQ (**3**) represent the vector current at a certain point due to the reflected waves. Then the instantaneous value of the current at that point due to the reflected waves will be QC.

Digitized by Google

Let OP be the vector current at the same point due to the oncoming waves. The instantaneous current due to the oncoming waves will then be PA.

The instantaneous value of the actual current at the point considered will be $PA + QC$, the sum of the two instantaneous currents due to the oncoming and reflected waves.



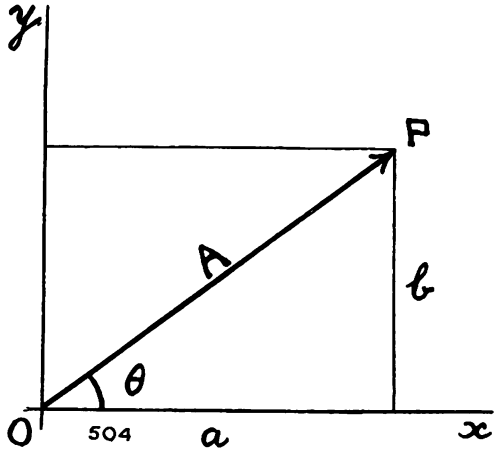
3.—Clock Diagram Representing Direct and Reflected Currents.

Complete the parallelogram $OPRQ$ and draw the diagonal OR. OR is of course the vector sum of OP and OQ. Draw the perpendiculars RB and PD. Then from the geometry of the figure we have $RD = QC$. Hence $RB = PA + QC$. But $PA + QC$ is the actual instantaneous current at the point. Hence RB is the actual instantaneous current at the point. Therefore OR is the resultant current vector at the point.

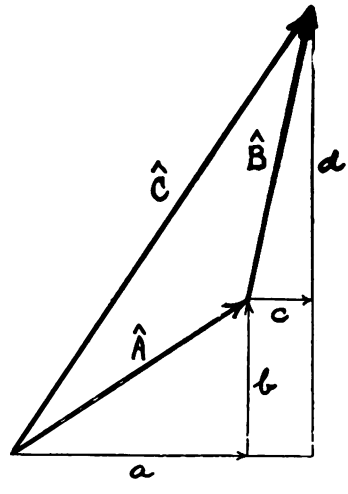
Digitized by Google

Thus the value of the current at any point in a circuit depends not only on the waves which reach that point from the sending end, but also on the waves which come back due to reflections further down the line. It may, of course, happen that the phase relations of the oncoming current vector and the reflected current vector at any point are such that the resultant current vector at that point is less than it would have been if no reflected waves were present. The resultant current vector at any point may have any magnitude between the sum and the difference of the magnitudes of the oncoming and the reflected current vectors at that point.

So far we have only been discussing the currents in the circuit. But, of course, the presence of these currents indicates the existence of corresponding electro-motive forces. There will be voltage waves



4.—Representation of a Vector.



5.—Addition of Vectors.

passing along the circuit, of the same length as the current waves, and, therefore, exactly as in the case of the current we can represent the variation in voltage at the different points along the cable by voltage vectors which rotate at the same speed as the current vectors.

The voltage vector at any one point will not, in general, be in phase with the current vector at that point. The phase difference between the current and voltage vectors at any point will, however, be constant for all points along the cable, so long as the type of the circuit is unchanged.

Mathematical Processes.—It will be seen from the foregoing brief sketch of the physical phenomena which occur in telephone circuits that we are in such investigations largely concerned with vector quantities. We can represent vectors graphically, and manipulate them mathematically by graphical processes.

Digitized by Google

It is, however, much more convenient to make our calculations by ordinary algebraical methods, and we therefore proceed to investigate how we can represent by algebraical symbols the vector quantities with which we have to deal.

A vector is any physical quantity which possesses in addition to its magnitude a definite line of action, and a definite sense in which it acts along this line. It may be represented graphically by a line, of length, to any scale, equal to the magnitude of the vector, lying along the line of action of the vector, and bearing an arrow head to indicate the sense of the vector. The vectors with which we have to deal are, as has already been explained, supposed to rotate. The phase relations, however, between any current or voltage vectors in any part of the circuit remain constant so long as the conditions of the circuit are unchanged, and we may therefore, in considering the relations between these current and voltage vectors, imagine them at rest, and separated from one another by the correct angular distances.

Let OP (4) represent a vector of magnitude A units, making an angle θ with the x axis. Let the rectangular co-ordinates of the extremity of the vector P be a, b. We use the symbol $\hat{A}$ to denote completely a vector of magnitude A.

A vector such as $\hat{A}$ may be represented algebraically in three ways. We may first consider the vector as having the magnitude A and making the positive angle θ with the axis Ox. Using this idea we write:

$$\hat{A} = A \angle \theta.$$

If the line OP had been drawn below the axis Ox the angle θ would have been negative, and we should then denote the vector thus:

$$\hat{A} = A \angle -\theta.$$

Another method of representing the vector $\hat{A}$ is by considering the two components a, b. It is a well-known fact that vectors may be added by what is known as the parallelogram law. Hence we have the vector equation—

$$\hat{A} = \hat{a} + b.$$

Now $\hat{a}$ and $\hat{b}$ are special vectors. $\hat{a}$ is along the axis ox, and $\hat{b}$ is at right angles to this axis. A vector known to be along the x axis, which is taken as the zero angular position, only requires to have its magnitude and its sense indicated. Its sense must either be in the direction Ox or in the opposite direction, and this is indicated by the prefix $+$ or $-$. Thus $+a$ or a completely specifies a vector, of magnitude a, lying along the Ox axis, and of sense in the direction from O to x. As a matter of fact all ordinary algebraical processes are vector calculations, but since they are exclusively confined to

Digitized by Google

vectors lying in the axis Ox no special vector signs except + and − are necessary.

On the other hand the vector b lies at right angles to the Ox axis, and we require some vector sign to denote this.

Consider the quantity $\sqrt{-1}$. We may be unable to form any idea as to what this quantity may be, but whatever it be, the relation $\sqrt{-1} \times \sqrt{-1} = -1$ must hold good. Imagine a vector b drawn from O along Ox. If we multiply this vector by -1 we obtain $-b$, or a vector of the same magnitude as at first, but drawn along the axis Ox in the opposite direction. Thus multiplying the vector by -1 has turned it through 180°. Since multiplying by $\sqrt{-1}$ twice is exactly the same as multiplying by -1, it follows that multiplying by $\sqrt{-1}$ twice will turn the vector through 180°. Hence multiplying the vector by $\sqrt{-1}$ once will turn it through half 180° or through a right angle, and we make the convention that this turning shall be in the positive direction. We may therefore denote the vector $\hat{b}$ at right angles to the axis Ox by $\sqrt{-1}\, b$. For convenience we denote $\sqrt{-1}$ by i (imaginary). Hence the vector $\hat{b}$ is written ib.

Thus our vector equation may now be written—

$$\hat{A} = a + ib.$$

Quantities such as this are called " complex quantities."

There is still one other method of denoting a vector.

We have—

$$a = A \cos \theta$$
$$b = A \sin \theta.$$

Hence, substituting for a and b in the equation just obtained, we have—

$$\hat{A} = A(\cos \theta + i \sin \theta).$$

Now it is shown in any book on higher trigonometry that—

$$\cos \theta + i \sin \theta = e^{i\theta}.$$

Hence,

$$\hat{A} = Ae^{i\theta}.$$

If the vector had been drawn below the Ox axis so that θ were a negative angle, we should have had—

$$A = a - ib$$
$$\text{and } A = Ae^{-i\theta}$$

It is easy to convert the expression for a vector from any one form to any other, using the relations—

$$A^2 = a^2 + b^2$$
$$\tan \theta = b/a$$
$$a = A \cos \theta$$
$$b = A \sin \theta$$

Digitized by Google

We now have to learn how to perform the four fundamental algebraical operations with vector quantities.

ADDITION OF VECTORS.—Suppose we have to add the two vectors $\hat{A} = a + ib$ and $\hat{B} = c + id$ and so obtain the resultant vector $\hat{C}$. We can add these graphically as shown in 5. But it is clear from this diagram that the components of the vector $\hat{C}$ are $a + c$ and $b + d$, or that the vector $\hat{C} = (a + c) + i\,(b + d)$. Thus to add vectors we add the real parts of the component vectors to obtain the real part of the resultant vector; and add the imaginary parts of the component vectors to obtain the imaginary part of the resultant vector.

SUBTRACTION OF VECTORS.—To subtract one vector from another, we change the sign of the vector which has to be subtracted, and then add the vectors. Thus:

$$\begin{aligned} & (a + ib) - (c + id) \\ = \; & (a + ib) + (-c - id) \\ = \; & (a - c) + i\,(b - d). \end{aligned}$$

Thus to subtract one vector from another we subtract the real parts for the real part of the remainder, and subtract the imaginary parts for the imaginary part of the remainder.

MULTIPLICATION OF VECTORS.—In multiplying vectors, it is more convenient to use the exponential form of representation. Thus, let $\hat{A} = Ae^{i\theta}$ and $\hat{B} = Be^{i\phi}$.

Then, $\hat{A} \times \hat{B} = Ae^{i\theta} \times Be^{i\phi} = ABe^{i(\theta + \phi)}$.

Thus to multiply two vectors we multiply the magnitudes of the vectors to obtain the magnitude of the product, and add the angles to obtain the angle of the product.

DIVISION OF VECTORS.—To divide $\hat{A} = Ae^{i\theta}$ by $\hat{B} = Be^{i\phi}$ we have—

$$\frac{\hat{A}}{\hat{B}} = \frac{Ae^{i\theta}}{Be^{i\phi}} = \frac{A}{B}e^{i(\theta - \phi)}.$$

Thus to divide one vector by another we divide the magnitudes to obtain the magnitude of the quotient and subtract the angles to obtain the angle of the quotient.

We sometimes have to square a vector, and also to obtain the square root of a vector.

From the rule of multiplication obtained above we have—

$$(A \angle\theta)^2 = A^2 \angle 2\theta,$$

Hence to square a vector, we square the magnitude and double the angle.

It follows at once that—

$$\sqrt{A \angle \theta} = \sqrt{A} \angle \frac{\theta}{2},$$

Digitized by Google

because by squaring the right-hand side of this equation we obtain $A \underline{/\theta}$.

It will be seen that the processes of addition and subtraction of vectors are best performed by using the $a + ib$ form, while the form $Ae^{i\theta}$ or $A\underline{/\theta}$ lends itself better to the other mathematical processes.

We may, however, multiply two vectors, expressed in the $a + ib$ form, remembering that $i \times i = -1$. We shall obtain a result in the form $p + iq$, and this result, on being converted into the $A \underline{/\theta}$ form, will be found to be identical with the product obtained according to the rule given above.

(*To be continued.*)

Digitized by Google

THE SEVERN BRIDGE AND ITS CABLES: EXTENSION OF THE UNDERGROUND SYSTEM TO SOUTH WALES.

By JOHN H. M. WAKEFIELD and H. G. TISSINGTON.

THE Severn Railway Bridge (Great Western and Midland Joint) carries the Severn and Wye Valley Railway across the Severn estuary between Sharpness on the east bank and Lydney, some 2½ miles inland from the west bank. The bridge, with the exception of the Great Western Railway Company's Severn Tunnel, affords the only direct means of communication south of Gloucester between England and South Wales.

The Severn Tunnel runs beneath the estuary, about eighteen miles to the south-west of the bridge, whilst Gloucester is almost an equal distance north-east.

The main underground route, Bristol to Birmingham, was tapped between Bristol and Gloucester, and a spur taken in 1910 to the east bank of the Gloucester and Berkeley Canal at Sharpness, owing to the Severn Tunnel being impracticable as a cable route. The work of extending the cable to South Wales was started last September, and as the tapping of the cable at Gloucester would probably have meant an additional expenditure of £80,000, the importance of the Severn Bridge as a direct cable route will be evident.

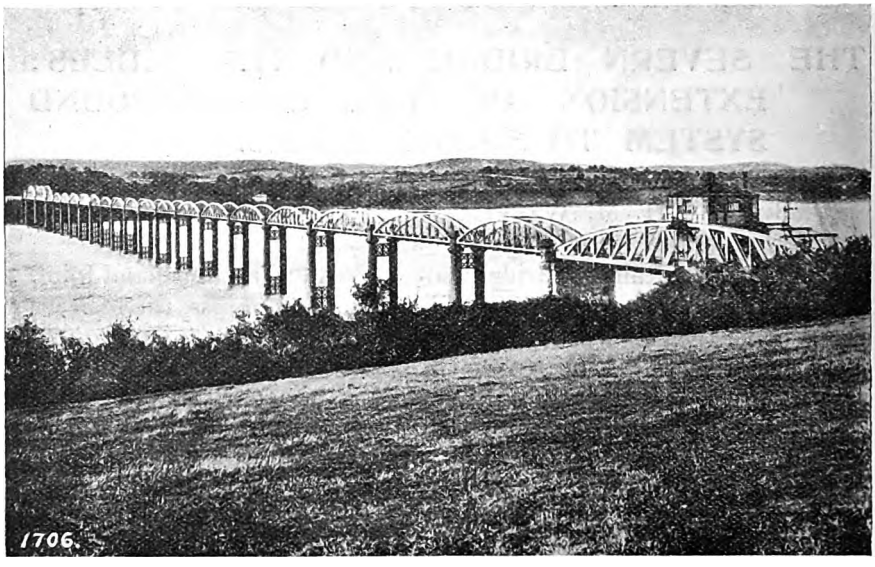
A photographic view of Severn Bridge is given in 1. The structure was opened for traffic on October 27th, 1879. From east to west the bridge is of the following construction, viz.:

A stone viaduct of three spans of 25 ft., wide enough for a double line of rails (2 and 3).

A swing bridge (1 and 4), double cantilever type, which crosses the Gloucester and Berkeley Canal on one side, and a portion of

Digitized by Google

the river Severn on the other. This bridge is 196 ft. in length and of sufficient width to take two sets of rails. The latter provision was made at an extra cost of £10,000 over the cost of a single line bridge in order to facilitate later on the widening of the remainder of the Severn Bridge, which is constructed for a single line only. The swing bridge is capable of describing a complete circle, and it is usually swung at right angles to the railway metals to permit vessels to pass up and down the canal. It stands on a central hollow stone pier (5) of approximately 39 ft. diameter, and over the bridge at this point is built a signal cabin (1), in which is housed the machinery for opening and closing



1.—The Severn Bridge from West to East.

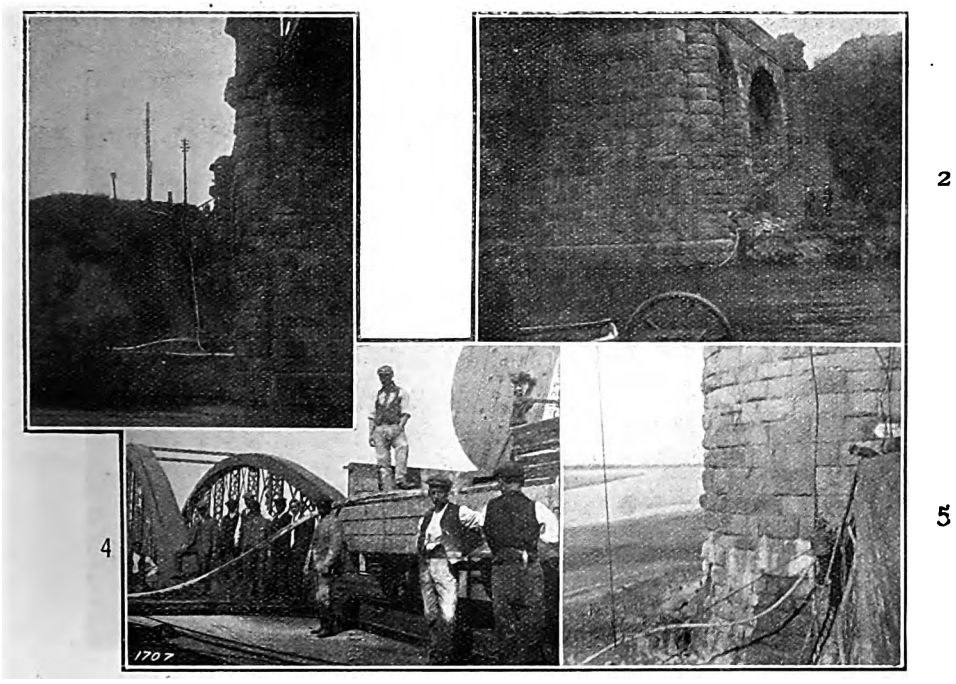
the structure. The motive power is derived from two pairs of steam engines—one of which is a reserve—which operate huge cogs, working on the exterior of a circular rack. The bridge swings round on rollers of 3 ft. diameter. The time taken to unlock and turn to fairway for ships passing on the canal is 2½ minutes, and the same period is required to lock the bridge in alignment for the railway. The weight of this portion, including machinery, is approximately 400 tons.

The main structure is continued over the river by means of thirteen adjacent bowstring spans, each 134 ft. long, and of 100 tons weight (6). Each span is fixed at one end, and works on rollers at the other. The fixed ends abut, so that the expansion and contraction points are at alternate piers. Except at the junction with

Digitized by Google

the swing bridge stone pier, the spans rest on piers composed of a pair of cast-iron cylinders, 6 ft. in diameter, braced together, sunk through sand and mud into the bed-rock of the river, and filled with concrete. Each cylinder is surmounted by a large girder bed-stone which seats one corner of the span.

Five bowstring spans of 171 ft. and each 150 tons in weight follow. These rest upon duplicate piers of cast-iron cylinders, 9 ft. diminishing to 7 ft. in diameter, and in other respects similar to the piers above described (1).



3.—From Truck to Bottom of East Bank.
4.—Paying Down Pier to River Bed from Swing Bridge.
2.—Across Canal, East to West.
5.—Passing Cable from River Bed through Wall to Canal Towpath.

The structure is continued by two large bowstring spans, 327 ft. long, over the deep channel of the river (1 and 7). They each weigh about 400 tons, and rest upon piers consisting of four C.I. cylinders, 10 ft. diminishing to 7 ft. in diameter, forming the corners of a square in plan, and braced together on each side and diagonally into a solid structure. They also are concrete-filled.

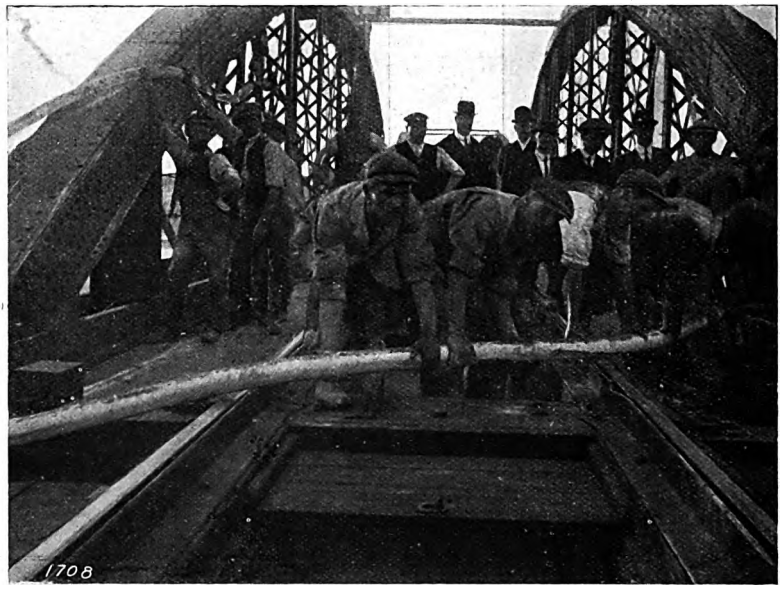
A further span of 134 ft. completes the bridge over the river, and then a fine stone viaduct of thirteen spans of 30 ft. length and 70 ft. above ground is continued over the Great Western Railway to the top of the west bank.

Digitized by Google

The clear headway given above high water ordinary spring tides varies from 70 ft. to 50 ft., and above low tide in deep channel, 100 ft.

The total length of the Severn Bridge and viaducts is 1387 yds., and the weight of iron in the structure is about 8000 tons.

The pier cylinders were sunk by excavating from inside with the water displaced by compressed air, varying in pressure from 15 to 35 lb. per square inch, supplied by a blowing engine through an air lock, which provided means of ingress and egress for men and material. The deepest cylinders are sunk about 48 ft. below dead low tide.



6.—Passing Cable Under the End of Span Abutting Swing Bridge (*see* **10**).

The distance between the rail packing and the vertical girders of the main section of the bridge is only 4 ft., a detail which effectually prevents any cable work being done under ordinary traffic conditions (7).

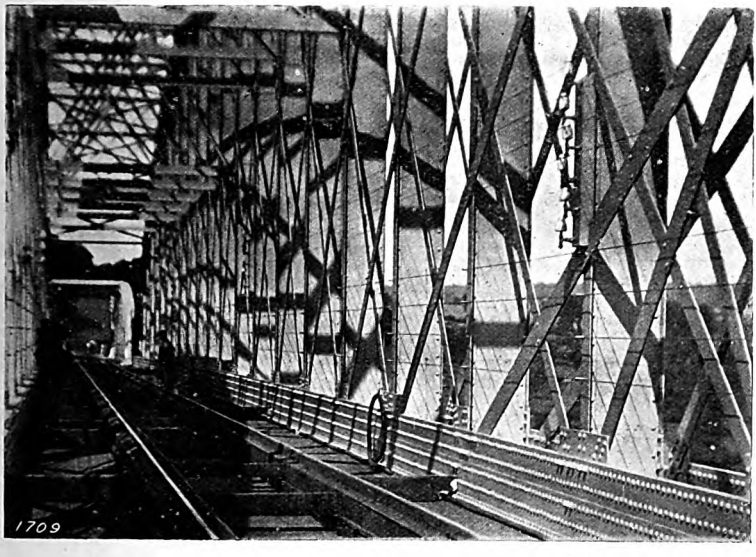
The Postmaster-General is in the happy position of having free wayleave powers over the bridge, and a number of cables have been laid down from time to time. The first cable was laid on the bridge in 1883. It suffered a good deal from the vibration, as did a Felton-Guilleaume cable laid later on. These cables were replaced in 1899 and 1901 by the existing 40-wire (40 lb.) paper-core, lead-covered, yarned and armoured cables with an over-all diameter of 2 in. One of these can be seen on the right in 7, which clearly shows the method

Digitized by Google

of looping adopted to provide for contraction and expansion. A loop in this cable is also visible at one of the piers on the left of 8.

A wooden shoe, some 5 in. long, hollowed out to fit the cable, is used immediately to the right and left of each loop, to permit of the loops being levered back into position when, owing to the vibration of the bridge, they have worked away from the vertical on the sun-heated, tar-covered plates.

A No. 4 iron wire is tightly bound round the top of each loop and carried thence to a screw clamp fixed to the ironwork of the piers. At one or two points, where there is not a pier, as in 7, the fixing wire is merely fastened to some portion of the lattice girder-



7.—40 Wire (40 lb.) P.C. Cable, Showing Expansion Loop in Centre of 327-ft. Span.

work. Two clamps are shown in 8, one on either side of the pier ironwork.

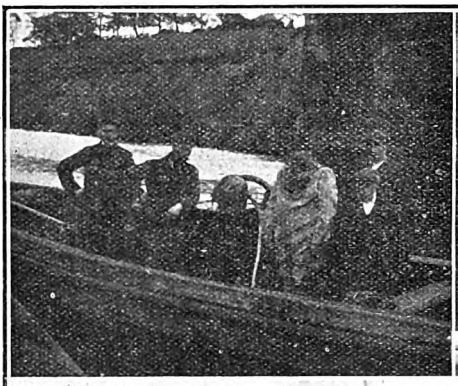
A second 40/40 armoured cable was laid in 1896 on the opposite side of the bridge, whilst at various times the following armoured cables have been placed under the river and canal at the swing-bridge end, viz.: six 4-wire 7/19 strand G.P.; one 6-wire 7/19 strand G.P.; one 8/100 P.C.; one 20/40 P.C; one 42/40 P.C.

All these cables are carried down one or other side of the stone pier immediately west of the swing-bridge, thence for some 45 yds in the bed of the Severn, up the retaining wall of the canal, under the canal towpath, across the canal, and ultimately up the steep incline to the terminal poles at the top of the east bank (3).

On Sunday, September 3rd, 1911, the work of laying a new cable

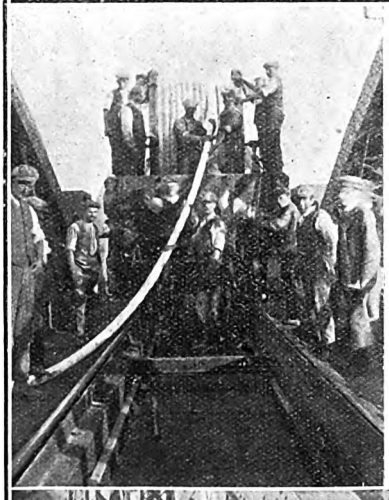
Digitized by Google

12



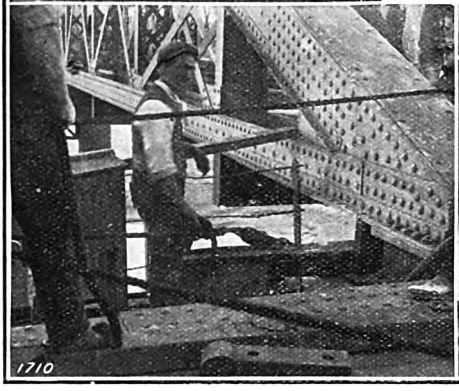
8

9



11

10



13

12.—The Diver and Party.
9.—Laying Out on the Bridge.
10.—Pulling Cable Under Bridge from Position Shown in 6.

8.—Making a Bight.
11.—Top of East Bank.
13.—Jointing on Bridge.—Armouring, Wires and Yarn Spread Out, Copper Conductor Joints Started.

Digitized by Google

along the bridge was commenced, in order to extend the spur from the main underground, mentioned earlier in this article. This is a lead-covered, yarned, and armoured cable, 24/150 quad pairs + 6/150 twin + 19/100 single screened + 9/70 single screened of 3·5 in. diameter (4). The armouring consists of 55 puddled iron wires, ·160 diameter, and of not less than 1220 lb. tensile strength. The cable weighs close upon 30 tons per mile, or slightly over 38 lb. per yard.

The magnitude of the work can be gauged from the fact that it occupied three Sundays for cabling and such jointing operations as were possible, and two further Sundays for jointing only.

Except in the case of an excursion or special train there is no traffic over the bridge on Sundays. Some interference with the work was, however, anticipated and unluckily experienced, owing to the opening of the swing bridge to allow ships to pass up the canal and the delay caused by the train staff rearrangements thus rendered necessary.

The work on the first Sunday was divided into three sections as follows: one set of men digging a trench 179 yds. long for a 4-in. pipe in ballast on the viaduct on the west side; a second gang laying out the cable on this viaduct and the bridge proper (9); and a third gang fixing one length of cable down the pier at the test hut near the swing bridge and laying it in the river bed. Towards evening the first gang and some men from the third gang commenced to thread on to the 179-yd. section of cable on the viaduct a 4-in. pipe, threading being necessary owing to the shallow depth at which the pipes had to be placed, and the bar-like rigidity and great weight of the cable.

Between 70 and 80 Post Office men, including jointers and plumbers, were engaged on the work on this day, and in addition the Railway Company had on duty a staff of engine drivers, signalmen and brakesmen, also platelayers for safeguarding the permanent way, and carpenters for enlarging the cuts in the horizontal struts (7) between the rail packing and side girders to allow the new cable to be laid close up to one of the existing smaller cables. Altogether nearly 100 men were employed. Most of these were obliged to lodge some three miles from the bridge, and a special train was therefore chartered to start from Lydney at 5.30 a.m. and return at dusk, whilst the engine was available for use throughout the day to deal with the trucks of cable as required.

The cable was laid to completion in the following lengths, starting from the west end of the bridge: two lengths of 180 yds., five of 200 yds., and one of 83 yds. down the pier (4) and in river, and one length of 104 yds. under the canal and up the east bank.

Each drum loaded with a 200-yd. length of cable weighed nearly

Digitized by Google

4½ tons, and it was hoped to make good speed with the laying out by employing the engine to pull the trucks steadily over the bridge between the points where bights had been arranged to be inserted. The first truck was, indeed, pulled for a short distance by the engine, but it was soon evident that the heavy drum could not be efficiently controlled in this way, and that it was advisable to be able to brake and stop the drum revolving in less time than elapsed between the signal being given to stop the engine and its actually coming to rest. Thereafter the trucks were hand-pushed over the bridge, which has a falling gradient of 1 in 137 west to east.

An idea of the stiffness and weight of the cable and the care which was required in dealing with it will be gained when it is stated that it occupied fourteen men the greater part of half an hour in forming a bight of the dimensions shown in 8. Altogether twenty-five of these sections were inserted, and they were, of course, made as the laying out proceeded. During the hot weather of last summer the writers measured nearly 1½ in. as the difference between the high and low temperature effects at some of the expansion points on the bridge.

On the right-hand side of the bight nine or ten men lifted the cable to form a half circle of from 8 ft. to 9 ft. radius, whilst three men kept the left hand side in position on the plates of the bridge. A stopper was then placed about 18 in. up on the left-hand side of the bight to keep it fixed, and as the first-named set of men carefully lowered the raised portion of cable on the right, it was simultaneously carried back towards the drum and pressed inwards to reduce the size of the half circle. The operations on the right-hand side of the bight were repeated several times until the bight was reduced to the shape shown in the figure. A stopper was then fastened on the cable as a base of the bight to prevent drawing out of the arc when the truck was pushed forward once more.

On the first Sunday, in addition to the trench and pipe-work previously mentioned, two lengths of 180 yds. and two of 200 yds. were laid on the bridge by eighteen men, whilst about a dozen men were engaged in excavating work only. One length of 83 yds. was paid down the pier and laid in the river bed by fourteen men, who were distributed to strengthen the other parties in the afternoon.

4 shows the cable being paid down the pier (test hut not shown, but close to the man on the extreme left of the view), and 5 shows the same length being pulled up and through the retaining wall of the canal, after leaving the bed of the river.

This section of cable required to be very securely stoppered as it was being paid down the pier, as the weight of cable between the truck and the bed of the river before it was turned round the buttress towards the canal wall and supported as shown in 5 was nearly a ton.

Digitized by Google

On the following Sunday twenty men were on duty to deal with the three 200-yd. lengths left over from the previous week. The first two sections were laid out in just over 2½ hours each—including the making of four bights in each length—after the truck had been got into position on the bridge. The last 25 yds. of the third length had to be taken underneath the bridge and placed on the ledge of the pier abutting the western end of the swing bridge, in order to lead into the test hut. 6 shows the method adopted to pay the end over the side of the bridge, thence to be pulled up and under to the hut as in 10, where the end of the cable can be seen as it emerges from beneath the bridge.

A good idea of the diameter of the cable is gained by a glance at the hands of the man in the four-foot way (6).

This portion of the work proved somewhat difficult and proceeded slowly, owing to the unwieldiness and rigidity of the cable and the fact that the new cable had to be kept clear of eight other cables lying on the ledge. Altogether, the handling of the third length occupied 4½ hours.

On the third Sunday—October 15th—the final section of the main armoured cable work was put in hand, viz. the 104-yd. length between the canal towpath and the east bank. A length of 149 yds. of unarmoured cable was also pulled into a 3¼-in. pipe laid under the sidings and Severn Bridge station approach on the west bank of the river and jointed to the armoured cable, and two new armoured 32/40 G.P. cables were also laid down as follows: Two 83-yd. lengths between the test hut on the bridge and the canal towpath; and two 104-yd. lengths between the latter point and the east bank. Three cables had therefore to be laid under the canal on the above date.

The cables had to be laid in a trench from 2 ft. to 3 ft. in depth, largely in rock from the top of the east bank to the east edge of the canal (2, 3 and 11). They were paid off direct from the trucks and fed down the bank over greased rollers placed across the trench, thence beneath the stone viaduct to the canal side, whence they were pulled across the canal by winches, and finally fixed by means of jagged staples and clamps on the sides and in the bed of the canal by a diver. The diving party, who were engaged on the work of re-fixing the existing cables and dealing with the new cables for five consecutive days, is shown in 12.

Here once more the stiffness of the large cable retarded proceedings, and it was with considerable difficulty that it could be made to fall into the canal trench and formation. 2 shows the end of this cable emerging beneath the stone viaduct before it was pulled across the canal to complete the new link which has been formed between the east and west banks of the Severn estuary.

Digitized by Google

Three separate gangs were again engaged on the third Sunday, one dealing with the unarmoured length of cable, another with the G.P. cables from the test hut to the towpath, and a third laying the 104-yd. lengths of G.P. and composite cable in the canal itself and up the east bank where the trench had been prepared earlier in the week. It was possible to release one gang soon after dinner, the remainder of the work being completed before dusk by about twenty-five men. The engine and train were dispensed with on this date shortly after mid-day.

13 shows a jointer at work on the bridge. The spreading out of the tarred yarn and armouring wires are clearly displayed.

We prayed for fine weather throughout, and got it!

Type-written instructions were issued to the foremen a few days before the work started, and each operation was constructed in advance as far as possible. The Superintending Engineer was present from start to finish.

This article would be incomplete without an acknowledgment of the excellent spirit displayed by the men engaged on what, in some respects, was distinctly trying and arduous work; and also of the very courteous assistance and co-operation shown by the Railway Co.'s staff—notably Traffic-Inspector Freeman—in connection with both the preliminary and working arrangements.

The photographs illustrating this article were kindly taken by Mr. A. W. Sirett, and Mr. T. Scholes, the Bridge Engineer, has been good enough to furnish many interesting details of the structure.

NOTE ON THE LAYING OF THE NEW ANGLO-BELGIAN PUPIN COIL CABLE, 1911.

By W. R. CULLEY, I.S.O.

ON 22nd August last two ships left Messrs. Siemens' works at Woolwich; one, the "Faraday," with 28 knots of cable, or sufficient to extend from St. Margaret's to near the Ruytingen bank, another, the "Helmsman," with 22 knots, to reach from the end of the "Faraday" section over the shallow banks with deep water passages between them to La Panne, the Belgian landing-place.

The "Faraday" was, of course, the well-known cable ship belonging to Messrs. Siemens; the "Helmsman," a small steamer with a large hold and only drawing 10 feet of water. She was temporarily fitted out with a bow sheave and leads for running out the cable, but had no regular cable machine on board, only a large horizontal V wheel driven by rope runners from her steam winch. This was

Digitized by Google

used for hauling the cable on board from the factory, and left on board in case of having to heave in any cable or discharge it.

The expedition was in charge of Mr. Stopher, of Messrs. Siemens, with a staff of cable engineers and electricians, while the Department was represented by Mr. Stubbs, myself, and by Mr. J. G. Hill, on board the "Faraday." In addition, there were Mr. Dieselhorst, Professor Breisig, of the German Administration, Mr. Corteil, representing the Belgian Administration, and several other well-known men interested in submarine telephony.

We left Woolwich on the morning of August 22nd, the "Faraday" proceeding direct to St. Margaret's and there laying down, during the night and following day, the buoys to mark the route of her section. The "Helmsman" followed with orders to wait in the downs until the "Faraday" started paying out and then to follow her.

On the morning of the 24th the "Faraday" anchored off St. Margaret's in position for landing the end, but the weather prevented this being done until the following day, the 25th, when with the aid of the Dover tug "Lady Vita" and a large iron barge the end was landed. All was ready for a start in the afternoon, and at 2.15 the anchor was hove up and the laying commenced. A little contretemps occurred just after clearing the Goodwin Sands, when, owing to a sudden and unexpected rush of tide, the port propeller struck the first mark buoy in passing, breaking adrift and sinking it. With this exception all went well with the paying out of the "Faraday's" 28 knots of cable, and the end was buoyed off the Ruytingen bank between 7 and 8 o'clock the same evening, the weather being fine and the sea smooth, but the tides running very strongly.

The "Faraday" then anchored, and the "Helmsman," having followed us out, anchored close to for the night.

The following morning—the 26th—Mr. Stopher, myself, and the "Faraday's" commander transhipped to the "Helmsman" and left for La Panne, landed there, and made arrangements for getting the end ashore over the long, flat, sandy beach, and then through the sand dunes to the cable hut some seven or eight hundred yards away. We also placed a beacon on the top of a sand hill to mark the landing place, and then, at low water, set a small red buoy at the water's edge, as it was proposed to come in with the cable at *high water* as far as possible and lay out sufficient cable to lead up to the hut at low water, when it was hoped the coil would be accessible.

During the night we placed the mark buoys to mark the shallow water section of the route. This was done with the aid of the various shore lights and the light vessels marking the various sands. The

Digitized by Google

1.—On "Faraday," Looking Forward from Stern Platform, showing Cable Run.

2.—The Cable and a Group of Notables. From Left: Mr. Dieselhorst, Mr. Stopher, Mr. Koetgen, Dr. Baird, Mr. Culley, Mr. J. G. Hill, Dr. Breisig.

3.—"Faraday" Paying Cable into Lighter off St. Margaret's Bay. Cable Hands are just about to take a Loading Coil Bridge.

Digitized by Google

Digitized by Google

night was a miserable one, the tides were running very strongly, and the wind and sea rose considerably. However, all was satisfactorily completed, and we arrived back and anchored again near the "Faraday" the following evening.

On the 28th we left in the "Helmsman" again, spliced on to the end of the "Faraday" section, and commenced to pay out over the Banks. During the night we had to anchor in one of the deep places, waiting for the tide to rise to get over the next bank.

On the 29th we again started in the early morning, and again had to anchor for several hours to wait for the tide and then continued. When within a few miles of the Belgian shore a fault showed in one of the coils, and we had to cut and buoy in the first deep water we came to, and then returned to the "Faraday" again, which in the meantime had moved into Nieuport Roads so as to be near at hand. On arriving on board we found that Mr. Dieselhorst and most of the visitors had gone ashore the previous afternoon and not been heard of since. Naturally this caused much anxiety, but they got back the next afternoon all well, having been detained by weather. Mr. Stubbs, however, had been obliged to return to Headquarters *viâ* Ostend.

On the 31st we again left in the "Helmsman" and commenced to pick up the cable towards the faulty coil. The fault was found in the second coil picked up. Then we had to splice in a new coil, pay out the cable picked up and again anchor to splice on to the cable on board. This took all night, and the following afternoon we arrived off the beach at La Panne, steamed close in to the low water-mark, it then being high water, put over sufficient cable to reach the hut, then returned to the "Faraday."

The next four days were taken up in getting the cable up to the hut, the tide not leaving the coil of cable sufficiently uncovered. However, on September 5th this was done, but not until many of the officers and men undressed, donned bathing suits, and swam and dived around the coils to clear the turns so as to allow the cable to be hauled up the beach. All this caused great amusement to the summer visitors at La Panne, who had, of course, never seen anything like it before.

Next day the two vessels left, each picking up their own mark buoys, and on arriving off Dover the "Faraday" proceeded to the Thames after landing the foreign guests, while the "Helmsman" went into Dover to discharge the spare cable into the Department's depôt there, and to complete the work on St. Margaret's beach. Thus ended the laying of the second pupinised cable.

W. R. C.

Digitized by Google

Technical Notes on the New Anglo-Belgian Cable.

By J. G. Hill.

The new Anglo-Belgian telephone cable represents a distinct advance in submarine cable manufacture, as compared with the Anglo-French cable, which was laid less than two years ago. The special features of the new cable are: (1) An improved dielectric consisting of a special modification of gutta-percha developed by the manufacturers. This has a much less leakance at telephonic frequencies than the gutta-percha formerly used, and its use overcomes one of the principal objections to loaded submarine cables of the G.P. type. (2) The cable is arranged on the "superimposed" or "phantom" circuit method, whereby three telephonic circuits are obtained from the two pairs of conductors in the cable.

The cable contains four copper wires, each weighing 160 lb. per naut and insulated by a dielectric weighing 150 lb. per naut (as compared with 300 lb. per naut in the Anglo-French loaded cable). Each conductor is made up of copper strands of ·036 in. diameter, with a central core of ·286 in. diameter. The cores are laid up around a centre of jute yarn, and, after the whole has been covered with prepared tape, the cable is brass taped and again wound with prepared tape. It is then served with jute and sheathed with iron wires. Finally, an outer serving of jute and compound is added. The sheathing over the coils is specially strengthened.

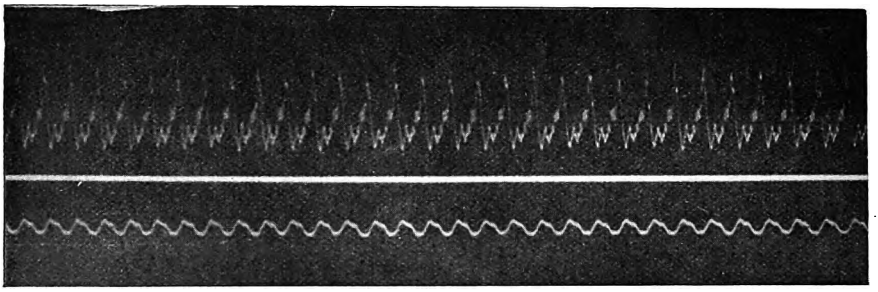
The total length of the cable is 47·9 nauts (88·9 kilometres) and the loading coils for all three circuits are placed together one naut apart (1·86 kilometres). The nearest coil to the English shore is 0·58 naut from St. Margaret's Bay cable hut, and from the Belgian cable hut at La Panne the distance is 0·35 naut to the first coil.

The electrical details of the cable are as follow:

Resistance per naut of conductor without coils	14·2 ohms at 15° C.
Capacity per naut (wire to wire) without coils	0·157 microfarad.
Capacity per naut of phantom circuit without coils	0·314 microfarad.
S/K at 800 cycles per second and 15° C.	12.
Inductance of a coil in the transformer circuit	0·1 henry.
Ohmic resistance of an inductive and a non-inductive coil in the transformer circuit	6·6 ohms.
Effective resistance of an inductive and a non-inductive coil of the transformer circuit at 800 cycles, with 1 milliampère at 15° C.	11·5 ohms.
Inductance of each coil in the phantom circuit	0·05 henry.
Ohmic resistance of each coil in the phantom circuit	3·3 ohms.

Digitized by Google

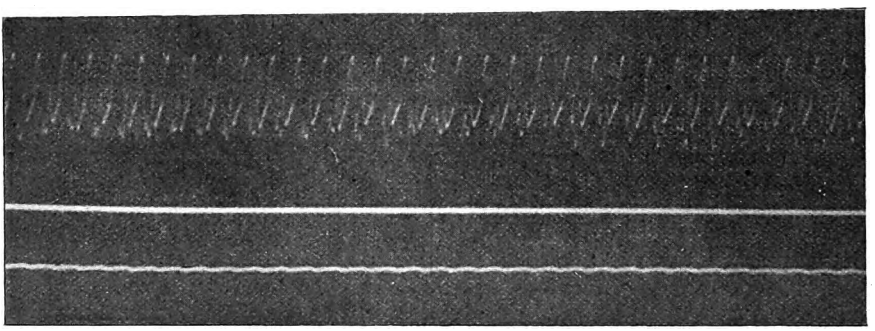
8



(1)

(2)

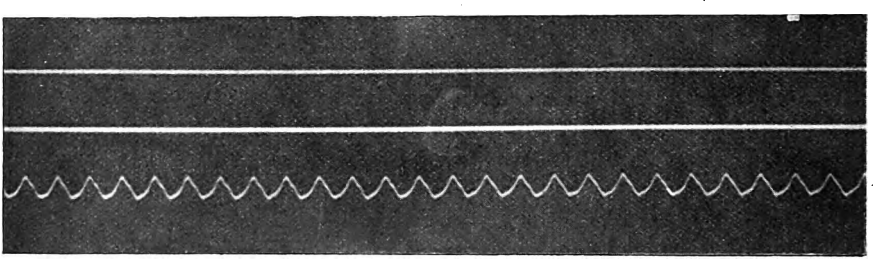
9



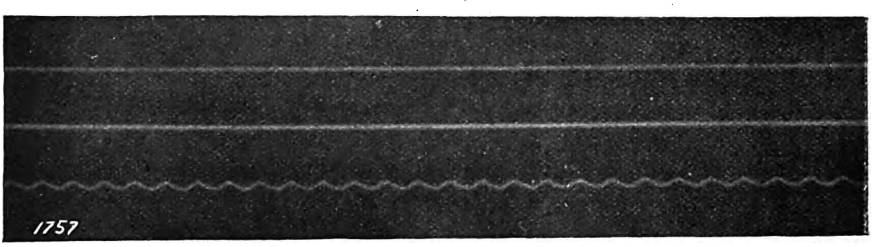
(1)

(2)

10



11



OSCILLOGRAPH RECORDS.

8.—LOADED CABLE.—RECORD OF LETTER "E," PRONOUNCED LIKE "E" IN "MEET."
9.—UNLOADED CABLE.—RECORD OF LETTER "E," PRONOUNCED LIKE "E" IN "MEET."
10.—LOADED CABLE.—RECORD OF LETTER "E," PRONOUNCED LIKE "E" IN "MEET."
11.—UNLOADED CABLE.—RECORD OF LETTER "E," PRONOUNCED LIKE "E" IN "MEET."

Digitized by Google

Effective resistance of each coil in the phantom circuit at 800 cycles, with 1 milliampère at 15° C. . . . . 4·6 ohms.
Capacity of each coil in the transformer circuit 0·004 microfarad.
Additional capacity of each coil in the phantom circuit, less than . . . . . 0·0001 microfarad.

The attenuation constant "β" as measured with a "Franke" machine at different frequencies, by Dr. Breisig, in a series of recent tests conducted on behalf of the German Administration, is shown below:

$2\pi x$ (frequency).	Mean "β" per naut of direct circuits.	"β" per naut of phantom circuit.
3000	·0157	·0156
4000	·0165	·0161
5000	·0177	·0173
6000	·0192	·0185
7000	·0204	·0195

The characteristic impedance "Z_0" varies irregularly with different frequencies on the three circuits, and does not appear to be the same from each end of the line. For the direct circuits an average value is 800$^{\omega}$ and for the plus circuit 400$^{\omega}$. The variation of attenuation with frequency is much less in the Anglo-Belgian loaded cable than in the Anglo-French loaded cable laid by the Post Office, and this favourable result is due to the use of the improved dielectric. It has not been found possible to entirely avoid overhearing between the transformer circuits and the phantom circuit, although the "direct" or "transformer" circuits relatively to each other are free from it. The amount of overhearing referred to was observed in London when the circuits were looped at the distant end of the cable at La Panne. It was equal in loudness to speech conducted through sixty miles of standard cable, forty-six miles of standard cable being the commercial limit of speech.

A series of oscillograms has been taken on a Duddell oscillograph, over the new and old Anglo-Belgian cables, for comparison, and the curves which are reproduced herein were so obtained. The two curves on the first photograph show (1) the voice curve as it was photographed on entering the cable with the telephone close to the sending end of the line, and (2) the voice curve after the current had passed completely round the two lengths of the cable (94 nauts.) in series. The difference in the amplitude of the two curves on the same photograph represents the attenuation, and the difference in their form represents the distortion brought about by the cable. It will be seen that in the case of the letter "e" the sound was almost wiped out in the case of the unloaded cable; and, therefore, in

Digitized by Google

taking the second photograph (representing the word "see"), the voice was much raised in speaking over the unloaded cable; the result is evidenced in the greater amplitude of the curves. The third record represents the same letter as record No. 1, but in this case only one length of the cable was spoken over, the speaker being at the cable end in Belgium, and the received curve taken at St. Margaret's Bay; the sending end curve could not therefore be recorded. A comparison of the first two records will show the improvement, both in volume of speech and articulation, brought about by loading the cable.

Speaking tests on the cable with the land lines connected as they will be in actual practice, were made from London by comparison with a standard cable. These tests show that when due allowance is made for the land lines, the attenuating effect of the cable is equivalent to that which is observed when speaking through eight and a half miles of standard cable. (The Standard cable has a loop resistance of 88 ohms and a wire-to-wire capacity of 0·054 microfarad per mile.) This is equivalent to a "β" of ·0188 at 800 periods per second against the value of ·0177 measured by the alternator. As the standard cable test was made in actual working conditions it includes all reflection losses, which in this case are small. The value obtained is within the limit laid down in the specification, and the manufacturers are to be congratulated on their highly creditable achievement.

J. G. H.

The photographs associated with this article were furnished by the kindness of M. Corteil the representative engineer on board the "Faraday" of the Belgian Administration. This opportunity to thank him furnishes also an opportunity to acknowledge the generous hospitality of the manufacturers in their entertainment of the Department's representatives as well as the unfailing kindness and courtesy of all on board the "Faraday."

A. J. S.

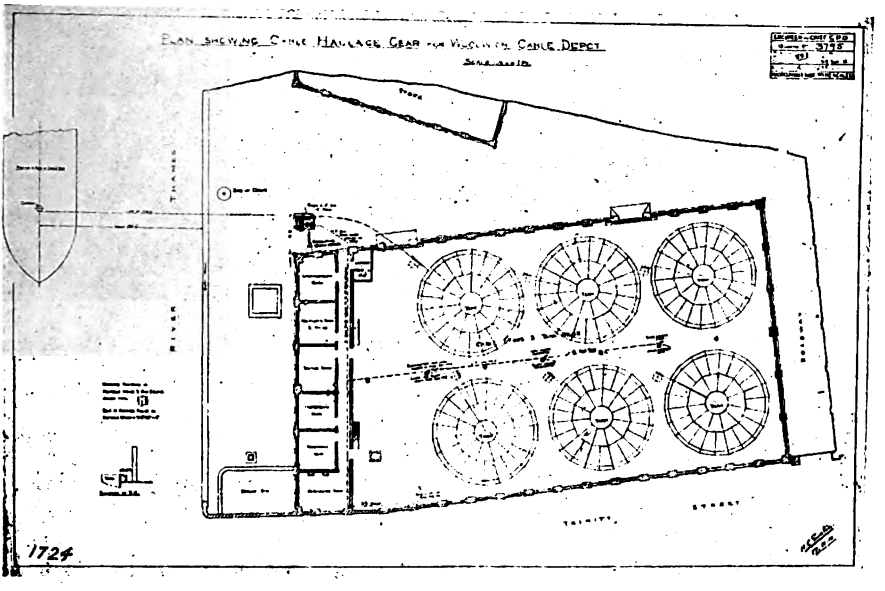
CABLE-HAULING GEARS.

By J. Coxon, A.M.I.E.E.

There have recently been installed at the Post Office Cable Depôt at Woolwich two cable-hauling gears for dealing with submarine cable, a description of which may show one of the many possible applications of the internal combustion motor to Post Office requirements.

Digitized by Google

H.M.T.S. "Monarch" has her moorings off the Depôt, and the depth of the river at low tide necessitates her lying about 170 ft. from the quay side. The approximate position of the ship, moored with bows up stream, and the relative positions of the cable depôt and cable tanks are shown in 1. In these tanks are coiled the various types of submarine cable likely to be required at short notice for repair purposes at any point round the British Isles. The cable stored varies from the light single deep-sea cable to the heavy 7-wire double shore-end cable, and the "over-all" diameter from about 1 to 3 in., the weight varying from about 6 to 30 tons per nautical mile.

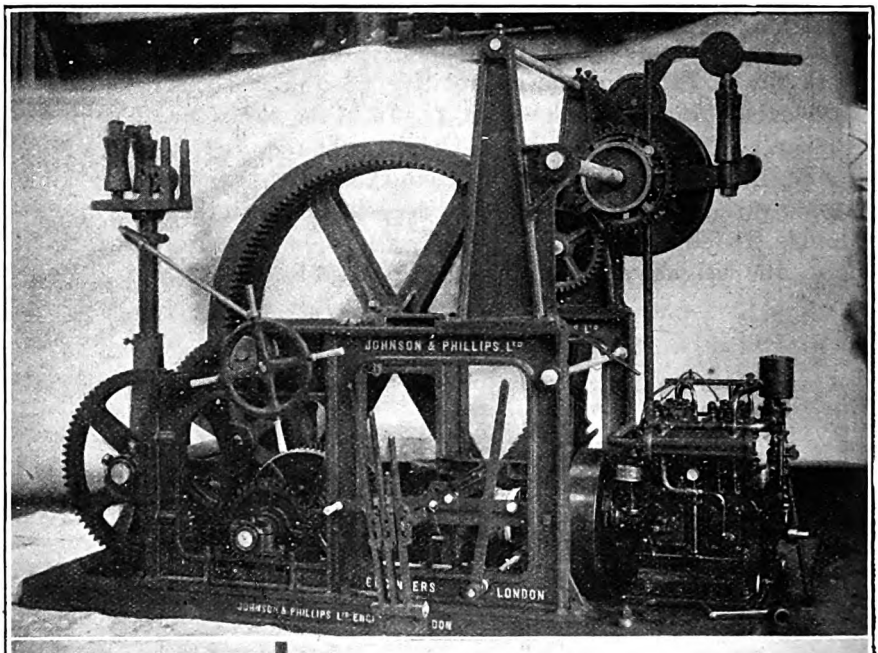


1.—Woolwich Cable Depot and Cable Ship at Moorings.

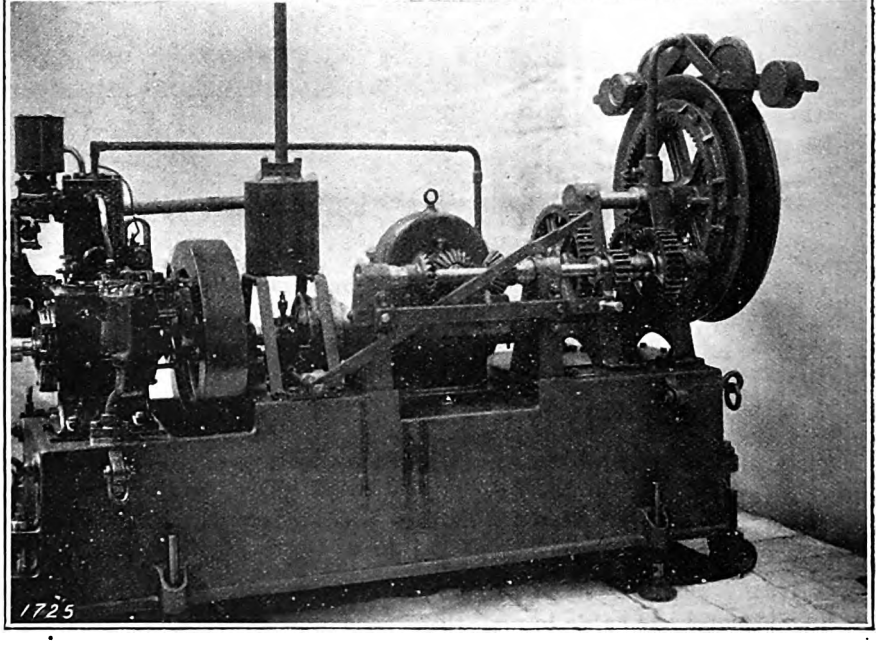
It frequently happens that the cable lying in the tanks on board the ship is not suitable for the repair and this has to be unshipped, or it may be that lengths of cable picked up at sea have to be unshipped, possibly for repair or to make room for other cable. The old method of unloading this cable consisted of hauling it from the ship's tanks by means of the steam winch on board, and coiling it into barges alongside. The loaded barges were then moved to the quay side and the cable hauled therefrom by a hand winch. Under such conditions the process was a slow and expensive one, and it was decided to provide some more expeditious method of doing this work by the employment of mechanical haulage. As it was impossible to obtain a supply of electricity at the cable depôt at reason-

Digitized by Google

2



3



CABLE-HAULING GEAR AT WOOLWICH CABLE DEPOT.

2.—FIXED GEAR. 3.—PORTABLE GEAR.

Digitized by Google

able expense, it was decided to adopt gas as the motive power for driving the winches.

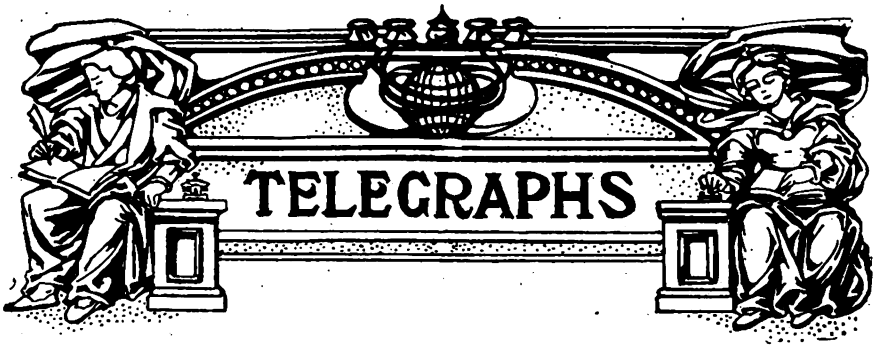
Two sets of gear, supplied by Messrs. Johnson & Philli s, have been installed. One consists of a fixed gear placed on the quay, and the other is a portable gear, both being capable of dealing with the heaviest cable at the minimum speed of ½ knot per hour or of dealing with the ordinary sized cable at a speed of 1½ knots per hour.

Photographs of each of these gears are shown. The fixed gear (2) has a main hauling drum 6 ft. in diameter by 1 ft. wide, which is fitted with clearing knives to prevent the cable over-riding on the drum, and with leading on and off sheaves, one of which is fitted with counting mechanism. This consists of a counter, geared to a disc having a circumference of one yard, which is pressed into contact with the cable, and serves to register automatically the length of cable dealt with. The winch is provided with reversing gear, and with two-speed gear giving velocities at the periphery of the drum of 50 ft. and 150 ft. per minute. It is fitted with ball thrust bearings and a Hele-Shaw disc clutch connecting it to the engine. The latter is a Gardner two-cylinder gas engine using Woolwich gas and giving 9 B.H.P. at 600 r.p.m. The engine is fitted with magneto ignition, and is water-cooled with pump circulation. Provision is made for emptying the tanks in frosty weather, and a suitable shelter is provided for this gear.

The portable winch (3) has a V-shaped hauling drum 3 ft. in diameter, and is capable of dealing with large or small size cables at the same peripheral velocities as in the case of the larger. This winch, however, has much less work to do than the fixed winch, as it is used for feeding the cable into the tanks from the main winch or for transferring the cable from tank to tank in the depôt. It is also provided with two-speed gear and reversing gear and fitted with ball thrust bearings and a Hele-Shaw disc clutch. It is driven by a single cylinder Gardner gas engine giving 6 B.H.P. at 850 r.p.m. This engine is also fitted with magneto ignition and is water-cooled by pump circulation, the water being contained in the cast iron tank forming the base of the engine. The whole of this gear is mounted on castor wheels, and can easily be moved to any part of the depôt. Four lifting screws are provided at the corners of the base, and when these are forced down upon the ground they take the weight off the wheels and so serve to fix the winch.

The gear was brought into use in October last and has been found to handle cable very satisfactorily and expeditiously. Owing to the considerable saving in time, the employment of fewer men, and the elimination of the cost of barge hire, it is expected that the capital cost of the gears will be recouped within five years.

Digitized by Google



THE QUADRUPLEX.

By W. A. Hatfield.

In this country quadruplex working is extending rapidly in spite of adverse climatic conditions.

With well-insulated aërial lines quadruplex is possible on circuits having a KR value of 70,000, but unfortunately the leakage is often so great that working is not always commercial on lines with half this value.

It might be anticipated that on underground lines, where the leakage factor is negligible, the KR limit might be more nearly approached, but on these circuits we have to contend with the high capacity, a factor which limits the extension of quad working to underground circuits with a KR value below 42,000.

When the B key is depressed and the position of the A key changed, the local circuit of the B side relay is broken during the time occupied by the received current in falling from a point above a (Fig. 1) to a point below b on the other side of zero, the points a and b representing the maximum strength of the A side current.

During this interval the armature of the sounder must be retained by the discharge from the condenser, and any factor which lengthens the time taken for reversal is deleterious.

Fig. 1 represents a reversal on an aërial line of low KR value, c–d indicates the time of reversal to the A side current valves. It will be seen that the time is very little more than the period during which the A key short-circuits the battery (o–o^1).

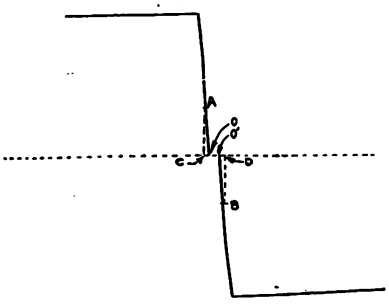
Fig. 2 indicates graphically the received current during a reversal on a line with considerable capacity. The interval c–d to be bridged over becomes much greater.

It is evident from these curves that capacity has a much greater effect than resistance.

A peculiarity of Curve 2 is that the short-circuiting interval, so

Digitized by Google

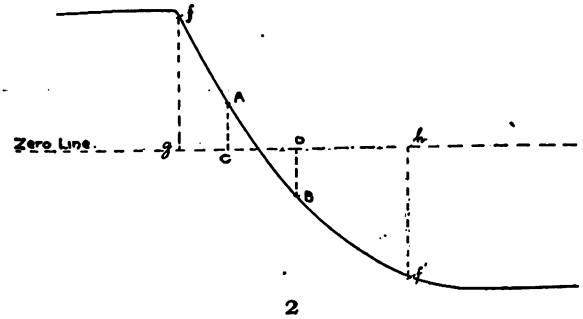
plain with the low KR in Fig. 1, ceases to be apparent when the line has a high capacity. From a study of these curves the desirability of adjusting the A key to give a minimum short circuit becomes apparent, and, if the effect of the spring of the non-polarised relay be considered, it will be seen that it is also important to so adjust the spring that its tension shall be as little as necessary above that essential to counterbalance the magnetic effect of the A current.



1

For example, should the B sides relay be adjusted with the spring as strong as possible, the current would have to reach f before the relay armature is attracted, and this would greatly increase the break to be bridged over by means of the condenser, the time interval in this case being that represented g-h.

It is also essential to keep the B side sounder spring as weak as possible. Arrangement can be made to bridge over any reasonable



2

interval, but the point is soon reached when the space between signals is also bridged, especially when letters like "o," "q," etc. are sent by operators who do not allow the key to rise properly between signals.

Mechanical senders may provide a remedy, or the time of reversal may be reduced by the use of a large inductance in leak.

The foregoing applies more particularly to long lines, but on very

Digitized by Google

short circuits quadruplex working presents another difficulty, due to the inductance of the apparatus at the distant station.

On a line of moderate length this is counterbalanced by the capacity, or rendered ineffective by leakage, but on a short line it must be compensated for.

Fortunately these cases are easily recognised when balancing, as the galvanometer indicates that a capacity less than nothing is required in the compensation circuit.

An inductance is therefore inserted at the further end of the compensation circuit, but not on the earth side of the condenser, or a condenser of small value put, as a leak, on the line side of the galvanometer.

On circuits worked from secondary cells resistance is sometimes inserted in the line to eliminate the trouble.

NEW IDEAS.

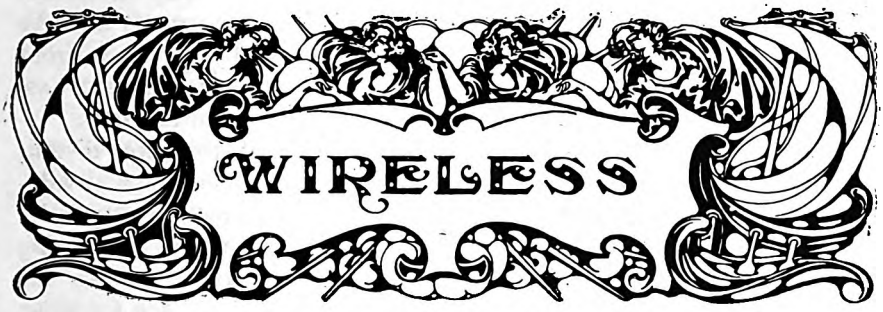
Improvements in Gell Perforators.

Some difficulty having been experienced with the older form of Gell perforators in consequence of the excessive current consumption, it has been found necessary to reduce the power absorbed from 200 to 100 watts. In the newer forms Mr. Gell has effected this reduction by the use of coil and plunger electro-magnets, in place of teams of iron-cored electro-magnets with pivotted armature.

The older forms are being converted at the P.O. factory, and very efficient results are being obtained from a form of coil specially designed by Mr. Mansbridge for the special requirements. This electro-magnet is also of the coil and plunger type, but it differs from that used by Mr. Gell in that it is a single coil instead of a pair, and is iron-clad. The construction is such that the magnetic circuit contains only a single air-gap, and the plunger, which is one inch in diameter, projects into the coil in such a way that when the coil is excited the plunger is very strongly attracted downwards, so as to bridge over the air-gap and complete the magnetic circuit. The stroke of the plunger may be anything that is desired. To obtain a long stroke the electro-magnet is constructed with its interior (hollow) poles one inch or more apart, while for a shorter stroke they may be only half an inch or less apart.

An incidental advantage of this type of electro-magnet is that it affords a cushioning effect for the plunger, since when the plunger has by its movement completed the magnetic circuit, the pull upon it automatically disappears. Hence when used on the punching side the motion of the plunger has not to be checked by any buffer or stop, and in consequence a better mechanical effect is produced.

Digitized by Google



THE POULSEN SYSTEM OF HIGH SPEED WIRELESS TRANSMISSION.

By J. E. Taylor.

A brief description of the stations and appliances for experimental high speed wireless transmission installed at Lyngby near Copenhagen and Cullercoats on the Northumbrian coast will doubtless be of some interest to the readers of this Journal.

The Lyngby station is situated a short distance outside the village of Lyngby nine miles north of Copenhagen in picturesque surroundings. It stands on comparatively high ground in undulating and wooded country. The actual site occupied is flat and the soil is of a sandy nature.

The form and principal dimensions of the masts, aërial, and capacity-earth are shown in the accompanying sketch (1). The aërial can perhaps best be described as of roof pattern, with the eaves joined by two fans of wires collected together at their lower ends on a horizontal insulated rod supported by two small poles, cabled, and led into the operating house. The house is situated midway between the two masts, but is displaced a little from the straight line joining them to allow a more symmetrical configuration of the aërial wires.

The two masts are 67 metres (220 ft.) high and are of wooden framework construction. The stays are of steel cable, well divided into approximately equal sections by insulators of wood. Each of the high stays is divided into five sections.

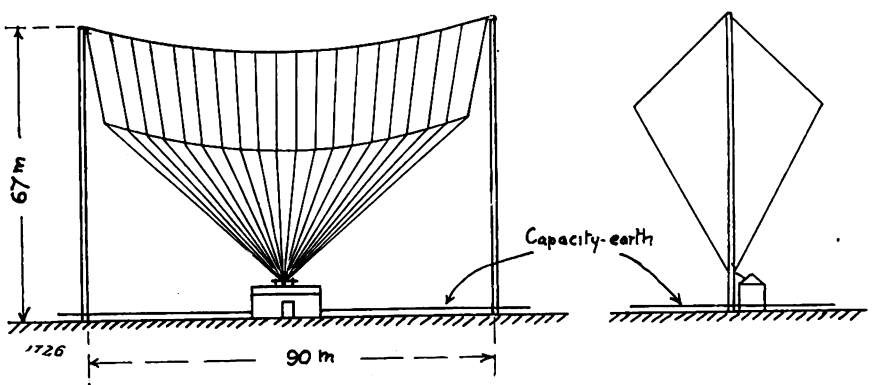
A capacity-earth, or counter-capacity, is ordinarily used, although a direct earth connection may be switched on when desired. It is claimed that the capacity-earth is preferred because of its constancy; direct earth-connection probably gives rather better range, but its quality varies from time to time. The capacity-earth consists of an extensive network of copper and galvanised iron wires, carried about 3 ft. above the ground by porcelain insulators on wood posts. The

Digitized by Google

network is distributed under the aërial symmetrically about the two masts, and projects somewhat beyond them; it covers an area of about 110 yds. by 46 yds., less a gap of 23 yds. by 17 yds. in front of the operating house. Its potential, when the station is transmitting, is only sufficient to spark across about $\frac{1}{2}$ mm. to earth.

A power-house is provided near one end of the site, distant perhaps 150 yds. from the operating house. It contains a 10 kilowatts, 500 volts D.C. dynamo, driven by belt from a two-cylinder vertical oil engine. There is an accumulator room containing a battery of 250 cells. The battery may be floated across the supply mains, and then allows drafts of power to be taken for short periods considerably in excess of the yield of the engine and dynamo.

The electrical arrangement of the station is shown by the



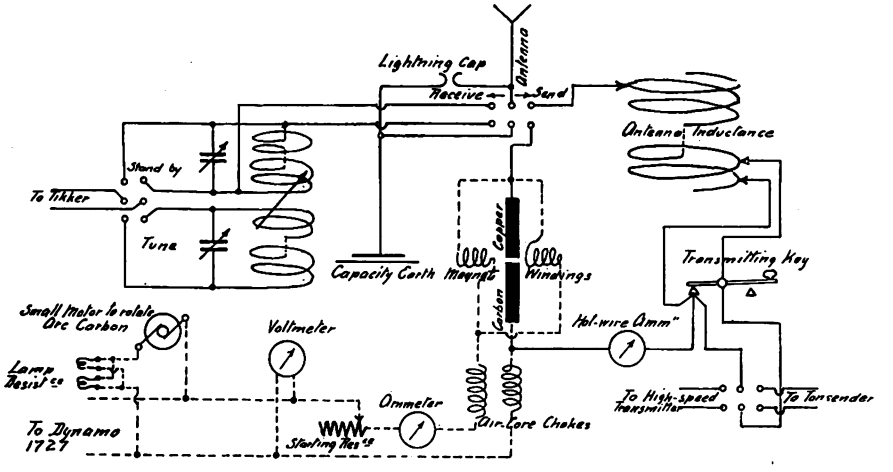
I.—Lyngby Wireless Station.—Form and Dimensions of Masts, Aërial, and Capacity-Earth.

diagram of connection (2). The arc, which is intended for 10 k.w., is inserted direct in the aërial lead between an inductance-helix and the capacity-earth, and is fed from the 500-volt mains through the windings of its magnets and two air-core chokes whose purpose is to isolate the supply mains from the high-frequency oscillations. In transmitting, the main arc and antenna circuits are not interrupted. The aërial radiates continuously, and "spacing" and "marking" depend upon which of two slightly different wave-lengths is being emitted. The key or other sending appliance intermittently short-circuits a small portion of the antenna inductance helix (generally one turn, sometimes less), thus intermittently reducing the wave-length by a small amount. The tuning at the receiving station is so fine that the small change in wave length so produced suffices to reduce the received effect sensibly to zero. The waves used in demonstrating the system were about 1500 metres, and the interval between the marking and spacing waves was varied between 5 per

Digitized by Google

cent. and 1 per cent. It is stated that good working is feasible with an interval of only ¼ per cent. The antenna inductance is of copper rod 7 mm. diameter formed into a helix about 11½ in. long, 17½ in. diameter, and containing 24 turns.

The station is equipped for sending by Morse key and by high-speed transmitter; also for key-sending to spark stations unprovided with the Poulsen (ticker) receiver, by the use of an appliance called the tone-sender. High-speed receiving apparatus is not fitted at Lyngby, and reception from Cullercoats is by telephone and ticker. The ticker is essentially only a trembling contact-maker and breaker, but its electrical action is somewhat complex, and is described below. The usual text-book explanations of the operation of this ingenious and sensitive form of receiver are not accurate.



2.—Lyngby Wireless Station.—Diagram of Connections.

At Cullercoats there is a single mast, 220 ft. high, supporting a large umbrella antenna. Here the high-speed receiver is fitted. Oscillations in the antenna produce a rectified discharge through a fine wire in a strong magnetic field, and the deflection of the wire is recorded photographically.

The high-speed sender, the tone-sender, the action of the ticker, and the high-speed receiver, are described in more detail below.

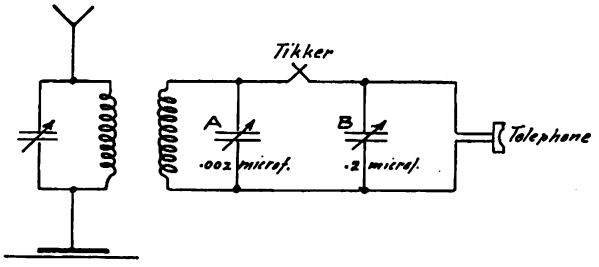
For communicating in the direction Cullercoats to Lyngby, a Poulsen arc transmitter of 3½ k.w. is used. The wave-lengths are about 1350 and 1280 metres.

The Poulsen Arc.—The arc in use at Lyngby is designed for 10 k.w., 25 amps. at 400 volts, but it is used at times with as much as 14 or 15 k.w. The carbon cathode and the copper anode are both 2·4 cm. in diameter. The main features of the arc are:

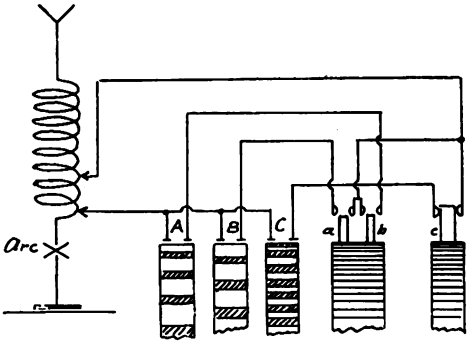
(i) Powerful transverse magnetic field across the arc-gap.

Digitized by Google

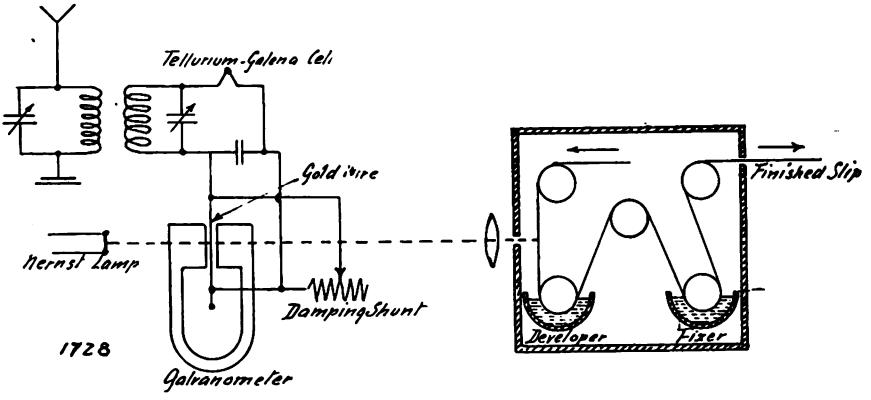
(ii) Steady circulation of hydrogen through the chamber enclosing the arc. The gas is generated in a separate shed by treating sulphuric acid with zinc. Alcohol and various liquid hydrocarbons



3



4



5

LYNGBY WIRELESS STATION.

3.—RECEIVING CIRCUIT. 4.—TRANSMITTER CIRCUIT.

5.—HIGH SPEED RECEIVER.

may be dropped on to the arc instead of feeding in hydrogen, with much the same effectiveness.

(iii) The arc chamber is cooled by a jacket with water circulation.

(iv) The carbon cathode is slowly rotated on its axis by a small motor with worm gearing.

Digitized by Google

(v) The anode is a removable copper ring screwed on to the closed end of a water-cooled copper tube.

The system of high-frequency arc transmission is described in British patent No. 15599, A.D. 1903.

For the best working of the arc it is necessary to change the carbon at intervals of half an hour or so, and the copper ring after, perhaps, every two hours of burning. The change of carbon is very quickly performed, requiring only a few seconds.

The arc-transmitter operates in a stable and quite satisfactory manner, variations of wave-length or strength of signals being little observable. It is necessary, however, for the operator to adjust the carbon electrode from time to time. In this he is guided by the indications of the hot-wire ammeter in the antenna.

THE POULSEN TICKER. — Referring to 3, the crossed lines marked "Tikker" represent two short thin gold wires at right angles to each other, one of which is made to vibrate against the other by an electro-magnetic trembler. The ticker contacts being open, oscillations of the frequency corresponding to the wave-length are rapidly built up in the inductance and condenser A, whose capacity may be about ·002 microfarad. At contact of the ticker wires, condensers A and B are put in parallel, and with the inductance oscillate at some lower frequency, viz. about one tenth of the former, since the capacity of B is some hundred times that of A. The ticker contact wires then separate, and at a moment of zero or small current, B, charged with nine tenths of the energy of the combination, becomes isolated from A. B then discharges through the telephone, producing an audible click. The important point is that the presence or absence of a current determines the conductivity of the minute gap between the wires as they begin to open, so that the instant of electrical disconnection is when the current is passing through its zero value.

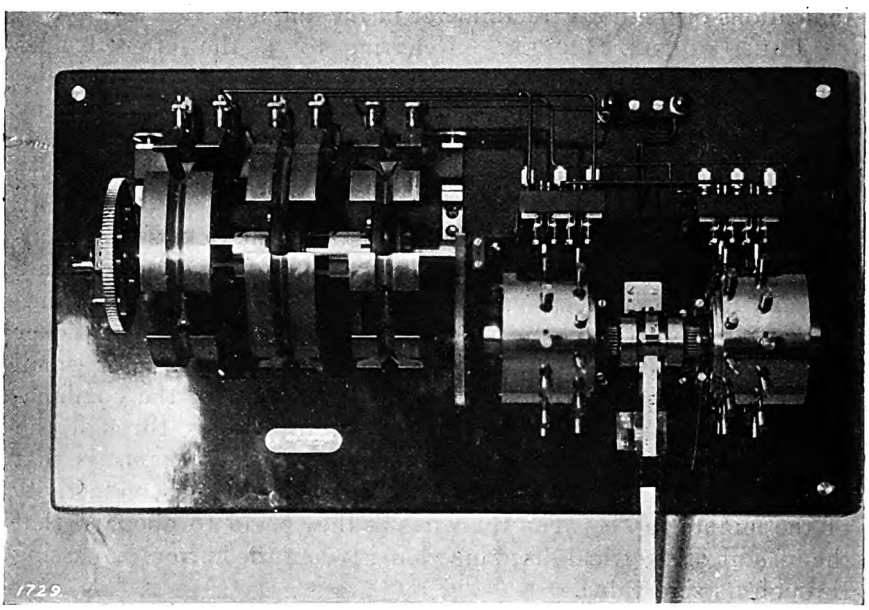
Signals from spark stations are rendered audible by the ticker, but for them to be readable the spark-frequency must be much higher than the ticker-frequency. British patent No. 4799, A.D. 1907 describes the instrument, and covers its use for wireless purposes.

THE HIGH-SPEED TRANSMITTER.—The high-speed transmitter is arranged to take messages prepared on perforated slip by a modified Wheatstone perforator. The perforator is modified by the removal of one punch each from the sets controlled by the dash lever and by the dot lever, so that a dash consists of a single perforation in the upper part of the slip and two centre perforations, whilst a dot consists of a single perforation in the lower part and a single centre perforation.

The transmitter (designed by Prof. Pedersen) is arranged in drum form, and the essential principle of its electrical action is as follows:

Digitized by Google

A mark is signalled by short-circuiting a portion of the aërial inductance helix, and this short circuit involves the closing of two separate contacts in series. Any sparking that occurs is therefore at the latter of the two makes and the former of the two breaks. These sparking contacts, determining the final make and break of the short-circuit current, are heavy, and do not depend on the punched slip for their operation. The slip controls the first make and second break contacts only, which, as they are not subject to sparking, may be of light construction. 4 is a diagrammatic representation of the transmitter. *A*, *B*, *C* are the heavy-contact drums; while *a*, *b*, *c* are rows of radial pins thrust outwards by the operation



6.—High Speed Transmitter seen from Above.

of the punched strip, and constituting the sparkless first line of contacts. *C* and *c* control the dots, while *A* and *a*, and *B* and *b* control the dashes. Dashes beginning on even centre perforations utilise *A*, *a*, while dashes on the odd perforations utilise *B*, *b*. 6 and 7 show the appearance of a recent design of the machine.

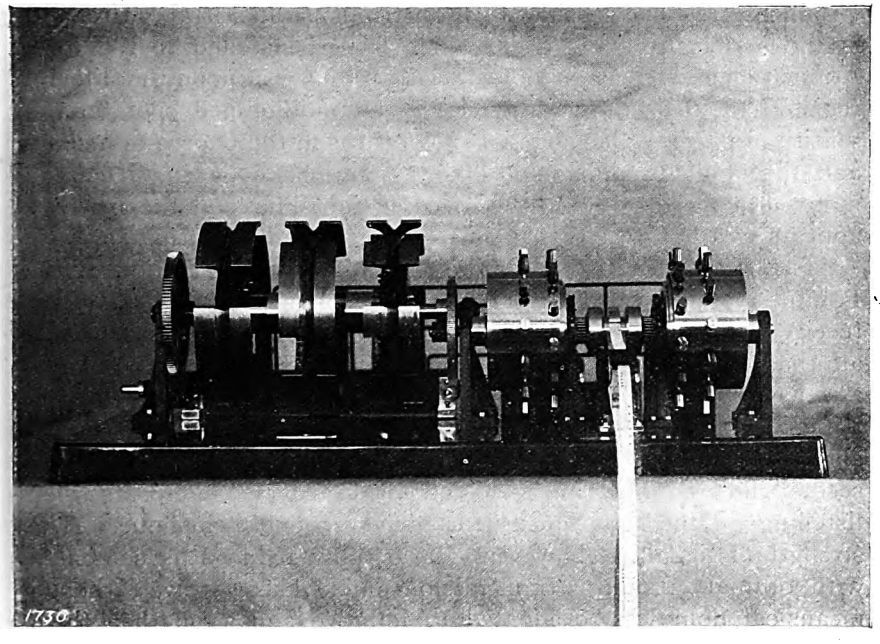
The three drums *A*, *B*, *C* are fitted with copper-marking segments and glass spacing segments, and copper brushes bear against them.* The pins *a*, *b*, *c*, projecting radially from the rotating drums or rings, are thrust outwards from the drum, so as to bridge the fixed spring contacts "knife-switch" fashion as they pass, whenever

* In the later form of transmitter shown in 6 and 7 air space insulation is provided between the segments.

Digitized by Google

small levers controlled by the plunger-pairs are projected through the dot-and-dash perforations in the paper strip. It will thus be seen that the controlling contact pins *a*, *b*, *c* are set in position in advance, to accord with the dot-and-dash perforations in the punched tape, and retain their positions during a part of the evolution of the drums until they have passed the spring contacts. They are then automatically withdrawn gradually to the normal positions.

The machine has been practically operated up to speeds of 300 words per minute, and it then appears to operate as efficiently as at



7.—High Speed Transmitter, View from Front.

the lower speeds. The Company have a number of machines under construction, in which sundry improvements are embodied.

It should be mentioned that in one respect the high-speed transmitter operates differently from the Morse key. Whereas the latter "marks" with the longer wave and "spaces" with the shorter, the former reverses this procedure, and the dots and dashes on the received slip appear as short and long periods of zero deflection. That is, the receiving apparatus remains quiescent during the marking periods, and is deflected during the spacing periods. The machine is covered by British patent No. 25190, A.D. 1909.

The High-speed Receiver.—A diagram of the high-speed receiver (at Cullercoats) is given in 5. The connections are those of

Digitized by Google

an ordinary rectifier receiving circuit except that the telephone is replaced by a modified Einthoven galvanometer. The rectifier is a tellurium-galena couple. The string of the galvanometer is a Wollaston gold wire of ·002 mm. diameter and about 100 ohms resistance, somewhat thickened at its centre by lamp-black deposit, stretched vertically between the poles of a powerful electro-magnet excited from a few accumulator cells. The wire is shunted by a variable resistance, so that its damping is under control. A beam of light from a Nernst lamp is projected in the direction of the magnetic field across the middle of the wire through a microscope, and on to a slit in an otherwise light-tight box enclosing the photographic gear. The sensitised paper strip is parallel to the wire, and is drawn along behind the slit, which is perpendicular to the wire. A much magnified shadow of the wire is thus cast upon the slit, and registers the deflection of the wire as an unillumined spot on the sensitised paper. The strip is drawn through the photographic box and through developing and fixing solutions by a small electric motor at a speed suited to the speed of signalling, and the message appears as a light wavy or "zig-zag" line on a dark strip.

THE TONE-SENDER.—For the continuous wave radiation of the Poulsen system to be audible in the telephone of a spark-system receiver, it is necessary to break up the marking waves into rapidly alternating groups of marking and spacing waves. For this purpose a rotary make-and-break, known as the tone-sender, is connected in parallel with the Morse key, and is driven at a high speed by an electric motor. The speed used gives about 1000 contacts per second, and a shrill musical note is heard at Cullercoats when listening on the tellurium-galena detector and telephone. The strength of signal is, however, considerably reduced as compared with ordinary Poulsen transmission and Tikker receiver, though means can doubtless be adopted to improve and strengthen them without detriment.

A very promising and satisfactory demonstration of the system at speeds of upwards of 200 words per minute was given across the 550 miles separating the two stations, thus furnishing ample proofs of its capabilities and opening up vistas of future applications and new fields for wireless telegraphy.

It should be mentioned that the system has also been operated, with larger transmitting power, over a distance of 900 miles between Lyngby and Knockroe in Ireland.

In conclusion, the writer must express his indebtedness to the Syndicate, especially mentioning Dr. Valdemar Poulsen and Prof. P. O. Pedersen for their extreme courtesy in affording valued information and for some of the illustrations, and to Mr. L. B. Turner for assistance given.

Digitized by Google

MAXWELL.

By And. Fraser.

Towards the close of the year 1841 there came to the Edinburgh Academy a ten-year-old boy whose rustic outfit and somewhat eccentric manner made him the butt of his class-fellows, who dubbed him there and then by the nickname of "Dafty"—a name the opprobiousness of which can only be appreciated to its full extent

James Clerk Maxwell.
(Reproduced by special permission of Messrs. Macmillan and Co., Publishers).

by a Scotch schoolboy. Little did his companions think that this same "Dafty" would one day become a man whom they would proudly look up to, and remember that he had been one of themselves.

The boy was James Clerk Maxwell, and amongst his school companions of those days were several who became distinguished in later life. At the beginning of his school career he was rather slow, but gradually improved until his fifth academic year, when he was regarded as the ablest mathematician in the school. In this year he gained the prize for English verse and the mathematical medal of the academy.

Digitized by Google

Impulsive, fun-loving, brimful of quaint and original ideas, he would pass from one subject to another in conversation with lightning-like rapidity—discussing an Euclidian problem one minute, and the next giving utterance to some jocularity distracting to those who happened to be listening.

About the time when he gained his medal, Maxwell had been investigating certain forms of various oval curves, the original ideas for which were suggested by seeing twisted candles in a grocer's shop some years before. The drawings which he produced excited the interest of Professor Forbes of the University, who, on April 6th, 1846, brought them before the Royal Society of Edinburgh.

In 1847 Maxwell entered Edinburgh University, and it is recorded that when the British Association was holding its annual meeting in the Scottish capital the members of Section A were astounded to see a mere boy get up and dispute with the celebrated Sir David Brewster some question in the theory of colour!

After completing his course at Edinburgh, Maxwell went to Cambridge. Here he appears to have been considerably ahead of the others, for we find him along with P. G. Tait (the late professor of physics at Edinburgh) working in advance of the ordinary college course of mathematics, and applying themselves to much more advanced work.

His eccentricity was noticeable even at this time, particularly with regard to hours of study and sleep. One of his contemporaries, writing of him, says: "From 2 to 2.30 a.m. he took exercise by running along the upper corridor, *down* the stairs, along the lower corridor, then *up* the stairs, and so on, until the inhabitants of the rooms along his track got up and lay *perdus* behind their sporting doors to have shots at him with boots, hair-brushes, etc., as he passed."

In 1854 Maxwell, who was then twenty-two years of age, came out of the "Tripos" as second wrangler. Of this examination, he said that before entering the Senate House his mind was a total blank. In a short time his ideas became unusually clear; but on leaving the room at the finish he grew dizzy, and was some time until he recovered himself.

Soon afterwards he became a Fellow of Trinity, and settled down to the routine work of college life, relieving it by investigations into colour, matter and motion, and electricity, his work in the last-mentioned being directed to giving mathematical expression to the ideas which he had learned from Faraday.

Two years later Maxwell was appointed to the Chair of Physics at Marischal College, Aberdeen, rendered vacant by the death of Prof. Gray. Much of his time here, apart from his class work, was occupied in an investigation into the structure of the rings of Saturn,

Digitized by Google

an essay on which gained the Adams Prize at Cambridge. It is doubtful if Maxwell was a success as a teacher; but his other qualities amply made up for any deficiency. Sir David Gill, the distinguished astronomer, speaking recently of those early Aberdeen days, says that although Maxwell talked over their heads, he was always willing, at the end of a lecture, to discuss things with his students; paying no regard to time until Mrs. Maxwell had to come and literally drag him away to dinner.

His humour does not appear to have appealed to the students in the granite city, for he complains on one occasion that he had not made a joke for two months and when he felt one coming he bit his tongue to repress it! Yet, although Maxwell found them lacking in a sense of humour, he found amongst them that co-operation which his work required; and it is interesting to know that after he had been transferred to Cambridge, Maxwell entrusted some of his most important research work to former students at Aberdeen. One of those students is with us to-day in the person of Prof. Chrystal, the distinguished mathematician who carried out the investigations into the truth of Ohm's law.

Passing on, we find Maxwell transferred from Aberdeen to King's College, London, where he remained for the next five years, at the end of which period he retired to his Scottish estate of Glenlair. For the ensuing four years Maxwell spent his retirement in laying the foundations of his great work on electricity and magnetism and in writing his Theory of Heat. In the former work Maxwell develops the ideas of Faraday—ideas which ultimately led him to regard light and electricity as essentially one and the same. From a consideration of the specific inductive capacity and magnetic permeability of a medium the velocity of wave propagation in it can be determined. This velocity or an electro-magnetic disturbance passing out into space was shown by Maxwell to be 3 by 10^{10} cm. per second, and to be identical with that of light. Maxwell stopped here. His mathematics and physical conceptions led him thus far. It was reserved for Hertz, of Karlsruhe, to establish the truth of Maxwell's results and to prove the existence of electro-magnetic waves, which, like those of light, could be made stationary and could be reflected and refracted.

"When the great work (his treatise on electricity and magnetism) first appeared in 1874," says Prof. George Forbes, "I remember Prof. Tait said to me, 'I must now make Thomson (Lord Kelvin) fulfil his promise. Twenty years ago he said to me, 'Tell me what electricity is and I will tell you everything else.' Since Maxwell's book has appeared he must redeem his word."*

Brought out of his retirement to occupy the newly created Chair

* 'Lectures on Electricity,' by Prof. G. Forbes.

Digitized by Google

of Experimental Physics at Cambridge in 1871 Maxwell, in addition to his work there, spent the remaining years of his life in editing the electrical papers of Cavendish—a task which, however commendable and desirable in itself, was regarded as an unfortunate one for science, inasmuch as it prevented him from carrying out original work that might have resulted in contributions of far-reaching importance to the science which he had made his own.

On November 5th, 1879, after a painful illness, the great physicist passed peacefully away.

Always of a deeply devout nature, the Christian side of Maxwell's character is well illustrated by a remark which he made on his death-bed to an old friend who was sitting by his bedside: "Old chap," he said, using the familiar speech of his undergraduate days, "I have read many queer religions in my time, but there is nothing like the old thing after all."

And now, let us ask, what is the verdict of posterity on the personality and on the work of Maxwell? By what standard are they to be gauged? Is our perspective sufficiently enlarged to enable a just estimate to be formed? The answer is to be found in the two brief extracts which we make from the writings of two of our most eminent scientists of to-day.

"The premature death of James Clerk Maxwell is a loss to science which appears at present to be utterly irreparable, for he was engaged in researches which no other man can hope as yet adequately to grasp and follow out; but fortunately it did not occur till he had published his book on electricity and magnetism, one of those immortal productions which exalt one's idea of the mind of man, and which has been mentioned by competent critics in the same breath as 'The Principia' itself."*

And lastly, speaking of the evolution of the science of electricity and of the way in which useless hypotheses had been discarded to make room for a rational theory which would harmonise all the various phenomena into one coherent whole, Heaviside says: "All this, and much more, was done. The crowning achievement was reserved for the heaven-sent Maxwell, a man whose fame, great as it is now, has, comparatively speaking, yet to come."†

Here, then, we leave that Maxwell, who entered upon the stage of human effort as the "Dafty" of his early schoolboy days and left it, recognised as the greatest intellectual force since the days of Newton.

[For much of the matter contained in this short biography the writer is indebted to Campbell & Garnett's 'Life of James Clerk Maxwell.']

* 'Modern Views of Electricity,' by Sir Oliver Lodge.

† 'Electrical Theory.'

Digitized by Google

EFFICIENCY IN SUPERVISION.

CO-OPERATION.—The keystone of organisation is mutual co-operation.

In general, routine business is governed by rules, regulations or precedent, and coincident and interrelated with the work is the necessity for intelligent and willing co-operation one with another. No man, therefore, has the right to say: "If I succeed I do not care what happens to anyone else." To be successful we must recognise the rights of others and believe that duty requires that we consent to help our associates. Every man should therefore feel that by helping others he helps himself.

We should remember that Chiefs are busy men; it takes about all of their time to run their jobs. Do not make your Chief's work harder by requiring him to give his time to the study of a report on some hypothetical question of no immediate or vital need. First study the matter yourself. Ask yourself the question—"Have I the answers to all questions which my Chief is likely to ask me in connection with this matter?" If you have not, find them; because in your answer will be found the solution. If you need your Chief's help to assist you in solving the problem, present your facts in as concrete shape as possible at an opportune time and talk the matter over with him, when the exchange of ideas may suggest new thought and the right solution.

ANALYSIS OF SUPERVISION.—What is supervision? Supervision is the power of the directing force to produce satisfactory results at a minimum expense with the least amount of wear and tear on the machinery. The best way of exerting this power is the personal influence of the directing force controlled by a fine appreciation of the Golden Rule, which is a high sense of the rights of others, our duty to them and our share in the betterment of the business as a whole.

Personal influence is the reflection of our own personality on the personality of another. Every man has two separate and distinct selves—one his own self or conscious self, the other his inner or subconscious self; the first lives within himself, the second lives within others.

The subconscious self is the reflection of the inner self on the inner self of others. The subconscious self is either received or rejected; the measure of its reception depends largely on the sincerity with which it is expelled. This subconscious self, being the unconscious reflection of the man himself, must be carefully developed wherever the control or direction of others is particularly concerned, so that in supervision we find the greatest need for it.

The success of a supervisor, no matter how thoroughly well-grounded he may be, will fall short of the ideal unless he is able to impress others with his broad-minded, impartial fair-dealing and honesty of purpose; that is, he must analyse himself and find the best method of dealing with himself before he can hope to successfully deal with others. It is a known fact that men

Digitized by Google

unconsciously are influenced by the example set by those above them in authority. Thus, if a supervisor is arbitrary and unreasonable the men in turn may reflect a like attitude in their dealings one with another. An unreasonable and moody man may inspire his subordinates with fear for his criticism but never with confidence in his judgment. Never let the petty irritations of to-day influence your attitude toward your subordinates. The man who lets his job "get on his nerves" loses his standing and influence with his men just as soon as it is said of him—"Look out for him to-day, he has a grouch." Be fair from the other fellow's point of view; try to deal with every man just a little bit better than he has a right to expect to be treated.

The extent of the influence you exert depends therefore entirely on your attitude towards things and men. You will no doubt be surprised at the quick response of men if you impress them favourably. The personal influence that you exert can be so directed that should it become necessary for you to seriously reprimand a subordinate for some breach of discipline or some error or omission of routine, that employee will be impressed with regret for his failure and earnestly desire not to cause the same trouble again. There are times when only vigorous speech will meet the requirements of the case. This does not mean to imply that we should generally "cuss out" our subordinates if occasion demands, but should point out without heat or anger in no uncertain terms where the standard has not been reached and the grade of improvement required for the future; so that there will be no question in the mind of such employee as to his having failed in such respect. In this direction great care must be taken to be sure that no sting remains, because we do not want to destroy our personal influence, that is, the employee's mental acknowledgment of the righteousness of our indignation. This personal influence can unquestionably be developed by individual experiment; that is, analysing the attitude toward us of those with whom we come in contact, applying diplomacy and a combination of tact and courage in our dealings with our associates.

The first is manifestly *Character*. In the selection of men the manly man only should be considered. He must be broad-minded, of a cheerful disposition, industrious, painstaking and conscientious.

He must have *knowledge*. Now in knowledge alone there is no ground for distinction between men until the feeling born of such knowledge produces individuality of consciousness which scientists have defined as one's own knowledge, so that there we have the application of the personal viewpoint on the knowledge acquired. The recognition of one man's knowledge from another is in the ability of that man to impart knowledge to others. The mind does not grow by keeping unchanged within itself faint and unconscious copies of its original experiences; but by assimilating something from each experience so that the next time it acts it is a more definite mode of activity than before. Consequently, some minds are slow to grasp or assimilate these experiences and have to be told over and over again how to do the same thing, and in the consideration and study of different mentalities with which we have to deal, we must be patient with those who are slow of understanding.

Digitized by Google

This brings to mind the condition of higher education in China. Each year approximately five thousand students present themselves for examination, and of this number about two thousand pass and receive the title which, translated into English, is "Budding Genius." These two thousand take the next examination and approximately one thousand pass and receive a diploma and title, the translation of the title being "Learned Scholar." Of the 1000 who present themselves for the final examination, less than 250 pass, when they obtain another diploma and title, the translation of the title being "Fit for Office." From the last mentioned class China selects its lawyers, statesmen and diplomats. The principal subject is the history of their country, which is learned entirely by heart from the commencement to the close. This develops in the Chinese, in the class of those "Fit for Office," extraordinary memories; but they have placed so much importance on memorising that they have overlooked entirely the necessity for the practical application of any fixed principles or ideas. That is, they can repeat correctly anything they have learned, but to apply that learning in its broad sense is not a part of their education. This is the reason why so many Chinese of the higher class enter our universities.

The illustration which I wish to draw for your consideration is that knowledge on any subject is of no practical use without ability to direct its application.

Following knowledge is *judgment*—ability to decide, based on previous experiences, as applied to the new condition. This requires that a man be a good listener, that he keep his eyes open and his mind alert and analyse the reason for cause and effect. In this connection it is essential that he adapt himself to his associates; not that this requires a "Hail fellow, well met" attitude, but a clear understanding of his own limitations and a reasonable conception of those of the men under him.

The next consideration is how best to apply these principles in our daily work. We should certainly cultivate a cheerful disposition and be friendly with our associates. A hearty "Good morning" on entering the office will not in any way detract from your dignity as a supervisor and will start the day with a comfortable feeling all around. Men should be treated as men, not as machines. If a man does a good job thank him for it, and telling him so takes very little time and shows an appreciation. Get every advantage and concession for your men that you can consistent with the rules and regulations. If a man should wish to be excused for a half day and it will not interfere with his work, grant the concession cheerfully and willingly and do *not* make the man feel he is stealing something.

This brings us to the consideration of *criticism.* Supervisors should learn to cultivate the critical faculty in its broadest sense. Now, criticism is of two kinds; one is that which instructs—explains where the mistake has been made and how the job should be done, and the other is the destructive kind which leaves a man with the impression that he is all kinds of an idiot and will not succeed anyway. Fault-finding is not criticism.

There is a certain use of the term, "So-and-so handles his men," which I would very much like to get into a dark corner and sandbag, because it suggests a patronising condescension based on a craftiness which is not above

Digitized by Google

an underhand playing of one man against another. As American citizens we object; we won't be handled in this manner, and consequently are internally indignant at the presumption of any person who tries it. If your attitude toward your men is that you believe in them, they will reciprocate a like feeling and endeavour to retain your good opinion. If, on the other hand, you approach a man with suspicion, that feeling will be reciprocated in the same measure as you reflect that attitude towards him. Give the men the impression that you are "on the level" and live up to it.

HABIT.—We are all of us slaves to habit. We get up in the morning, come and go through the day largely from habit. Some of us have good habits and some of us have bad habits. How many of us have ever stopped to analyse what we really have done at the close of the day's work; then see what we could have done more satisfactorily if we had not allowed habit to shape our actions. Frequently habit of speech does great harm, and there is one I have in mind—when the supervisor, in righteous anger at some careless mistake in answer to the book-keeper's explanation that he "thought" thus and so, replies: "You are not supposed to think, you are supposed to follow instructions." Now this is another one of those things that I would like to sandbag. If any man has an idea that he can do all the thinking that is necessary for the men under him, he is very greatly mistaken. Each one of us to do our own job must think for himself and encourage others to think for themselves. Constructive thought, that is the analysing or reasoning out for the development of new methods or improvement of old ones, is made easy or difficult in proportion to the reliance we can place on the thoroughness of thought by others on whom we must depend for part if not all of the facts and their co-relation to the matter in hand. In supervising we must direct the thought; that is, we must point out the need for thought with special reference to the dangers of not thinking when the opportunity presents.

SUCCESS AND FAILURE.—If you will show me the man who has made nothing but success of his undertakings, I will show you the man who knows nothing of success. True success is born of failure; that is, it is by taking advantage of the experiences taught by failure that we finally win success.

Hanging on the wall, when I come down to breakfast every morning, is a sign which reads: "Life ain't all in holding a good hand, but in playing a pore hand well." I get a certain amount of satisfaction and refreshment of spirit every time I see it.

Let us take heed, therefore, how we relax our effort for better things to the fancied easy enjoyment of an assured job with no special need for anxiety.

I realise that the principal difficulty blocking the path of radical improvement is an imaginary sensitiveness and apprehension on the part of the individual that immediate beneficial results will not be forthcoming from any change in habits acquired from previous experience, and this is very largely true, unless the renewed activity be kindled by a vigorous enthusiasm born of courage of conviction.

As a suggestion for a start in the renewed activity let each man take a survey:

First: What is your job.

Digitized by Google

Second: With what material have you got to work; that is, the willingness of the men under you and something of their general qualifications and characteristics, allowing no prejudice to influence your judgment.

Third: The best method of approaching each individual.

Fourth: The condition of the work of each individual and a summary of the total.

Fifth: Determine the relation between what the men are actually doing and what they could do.

Sixth: The cost of doing the work.

Seventh: Your estimate of what the cost of doing the work should be.

Eighth: Compare such costs with others in the same relation.

(*E. C. Mitchell, in the 'Telephone Review.'*)

Digitized by Google

AUTOMATIC TELEPHONY.—In our last issue we told our readers that we hoped to present in this issue an article on "Automatic Switching" by an officer who is closely associated with the Post Office installations now in progress. We are pleased to say that the gentleman referred to, Mr. W. J. Bailey, of the Engineer-in-Chief's office, has contributed a detailed description of the new switch at Epsom, together with a splendid series of illustrations and explanatory diagrams. It was intended to make Part I of Mr. Bailey's article a feature of this number, which commences our fifth volume, but so great is the pressure of current matter that, in spite of a very considerable increase in number of pages, space is not available for a satisfactory instalment, and we are therefore holding it over for our next issue, which will be a special Automatic Telephony number.

THE TELEPHONE TRANSFER.—When the last number of the JOURNAL went to press, the transfer to the Post Office of the great undertaking of the National Telephone Co. was still a thing of the future, looming large on the immediate horizon.

This important event in the history of British telephones is now an accomplished fact, and we wish to take this earliest opportunity of bidding a hearty welcome to the great army of new colleagues which has now joined our ranks, and which will in future march side by side with us under the broad banner of the Post Office. The Postmaster-General himself has well expressed the feelings with which we greet this magnificent reinforcement of brave men and fair ladies, and the POST OFFICE ELECTRICAL ENGINEERS' JOURNAL feels itself fully authorised to proffer, on behalf of the whole service of Post Office Engineers, the most sincere good-

Digitized by Google

will and friendship to those who have become officers of the Engineering Department. We cannot help regarding them as the *élite* of the Company's staff! We know they are men of enterprise and of proved ability, and trust that they will lend both strength and dignity to our common service. We are pleased to know that a large proportion of them have been readers of this JOURNAL from its beginning, and we hope that in future we shall be able to count upon their active support as contributors and also as energetic members of the Institution of Post Office Electrical Engineers.

The transfer has been looked forward to by the staff on both sides with feelings in which hope has been blended with a considerable amount of misgiving. On the one hand, it has seemed clear that the unification of the telephone service, and the removal of the artificial condition under which it has laboured for several years, should presage a healthy and steady development conducive to the prosperity of the staff, while, on the other hand, it has been manifest to everyone that the initial dovetailing together of the personnel is a task of such delicacy and complexity that, no matter how ably and how fairly it were carried out, it could not fail to produce much disappointment and much heart-burning on both sides. It is happily the case that on all hands the genuine desire of the controlling officers of the Post Office to mete out even-handed justice is known and appreciated. To those of the old Post Office staff who feel aggrieved by the appointment of men, younger and with shorter experience than themselves, to superior positions, we would point out that under the Company's system of selection young men who have proved their usefulness have come to the front more rapidly than is generally possible in a Government Department, and that it is quite impossible for the Postmaster-General to ignore the *status quo* in this respect.

On the other hand, the Company's men who are disappointed with the result of their final classification, whatever that may be, should remember that the great bulk of the Post Office staff on the same grade have only reached their positions after a long period of service and a series of examination tests which have precluded advancement on the grounds of service ability alone. And there is also a useful, and, it may be for them, a comforting moral to be drawn from the many cases in which men who left the National Telephone Company and joined the ranks of the Post Office several years ago, now find that colleagues who were their equals in the Company's service have been appointed at the transfer to grades superior to those which they themselves have been able to reach in their period of Post Office service.

It is much to be regretted that the immature state of the valuation proceedings has made it necessary for the Company to retain

Digitized by Google

for a time the services—in some cases, part of the service—of a considerable portion of their staff. This condition delays the fusion of the two systems, extends the period of uncertain organisation, and postpones the day, to which we all look forward, when the combined staff will have settled down to clearly defined duties and will be able to pull all together as one. When that day arrives we may hope for great things.

We well recognise the school of strenuous endeavour in which our new colleagues have been brought up. In a recent article in the 'National Telephone Journal,' a valued contemporary, now, unhappily, defunct, the individual members of the staff were urged to accept as their motto: "The Company first, last, and all the time." We welcome this spirit, and we think that among the varied impressions of the Post Office that will mature themselves as time goes on, not the least definite will be found to be the whole-souled way in which this definition of the duty of service has been accepted and acted on in the Engineering Department. For many years it has indeed been a case of "all the time" in a more strictly literal sense than the author of the exhortation probably intended.

Loyal and devoted endeavour is even more essential in a Government Department than in a private corporation. The difficulties of dealing with "slackers" in the public service are greater, and unfortunately the difficulties in the way of rewarding the willing horses that shoulder the load are greater too. The interdependence of public departments is great, and their organisation is necessarily complex. A man in almost any position can hardly help feeling that he is but a small cog in the wheels of a big machine that will go on acting independently of his efforts, and will not be greatly affected by either his best or his worst. Character is needed to realise effectively that in the all-important composition of the aggregate soul, that of the humble individual unit really counts for everything, that it is the sum of his efforts that steers the course and shapes the final balance-sheet. Men of energy and men of gifts are needed as much in the Government service as anywhere, but, above all, those are needed who will exercise their gifts and their energy unselfishly, apart from the scoring of personal points or the gathering of official *kudos*. It is a much easier thing to find men who will do brilliant work in the limelight—"with trumpets also and with shawms"—than to find those who will bring equal talents to bear on the tackling of uninteresting drudgery, "keeping things straight" for others as well as for themselves, knowing that however great the results of their work may be, they will not appear on the surface and will not gain applause or be rewarded by an *ad hoc* promotion. Such men are indeed worth their weight in gold; appreciation of their value may

Digitized by Google

not come suddenly, but it grows steadily, and on a sound foundation that in the long run assures permanent recognition. T. F. P.

IMPERIAL WIRELESS SCHEME.—A printed circular letter was issued by the Marconi Wireless Telegraph Company on March 7th intimating the acceptance of the Company's terms for the construction of the first six long-distance wireless stations, which are to form a means of linking up Great Britain with the various British Colonies throughout the world. It is an open secret that the consideration of this scheme has occupied the attention of a Government Committee for many months past. It is hardly necessary to dwell upon the far-reaching consequences of the policy adopted and the likelihood of further expansion. Stations are to be erected as follows: England, Cyprus or Egypt, Aden, Bangalore (India), South Africa, Singapore. These are to be put in hand immediately.

The sites have not yet been finally decided upon, but it is fairly certain that the English station will not be situated in London. A sum of £60,000 per station is allotted as the price to be paid to the Company for the plant and installation. Sites, foundations for machinery and buildings for stations and for residential quarters are not included in this amount. In lieu of royalty payments the Company are to receive 10 per cent. of the gross receipts for traffic over a period of twenty-eight years. The Government will have power to terminate the agreement at the expiration of eighteen years, but would, in that event, cease to have the right to use any of the Company's patents then in force.

The stations will be required to communicate reliably, day or night, over at least 2000 miles. In embarking on such a policy it must be evident that the sway of wireless telegraphy has increased, and that it has come to play a new *rôle* the magnitude of which it is difficult to estimate. The bogey of unworkable interference between stations having slowly but surely been dissipated, long-distance wireless telegraphy is about to assert its place in the general scheme of human progress. J. E. TAYLOR.

P.O. ENGINEERS' CONFERENCE.—The Second Annual Conference of Post Office Engineers, held in London under the auspices of the Society of Post Office Engineers on January 27th and 28th last, proved an event of more than passing interest. Every district was represented, and the number of delegates attending was even larger than last year. The interest evinced by the Post Office Engineering profession was plainly shown by the fact that both on the afternoon of the 27th and throughout the whole of the sittings on the

Digitized by Google

28th a considerable number of visiting engineers were present at the discussions.

The topic of chief interest was the recent engineering reorganisation. The whole of the first session of the Conference was devoted to its consideration, and then by unanimous consent the time devoted to the other and important items on the agenda was rigidly curtailed that the Conference might spend whatever time remained in a discussion of this supreme topic. Even the question of the National Telephone Company's transfer, which in normal circumstances would have loomed large and provoked keen inquiry, occupied but a relatively small space in the field of discussion.

The unanimity of the mind of the delegates on the subject was evidenced by the fact that although each district had furnished separate resolutions, it was found practicable to combine the fifteen resolutions into one, and yet satisfy the delegates of every district in the kingdom.

The prevailing note of the Conference was undoubtedly one of great disappointment with the method of application of the new scheme. Attention was specially directed to the cases of two officers, one still in the probationary stage, with about twelve months' engineering experience to his credit, to whom official responsibility could not safely be extended, but who is, nevertheless, graded as an assistant engineer; the other an engineer of long experience and honourable service, possessed of undoubted technical and organising ability, whose "personal equation" is irreproachable, who for four years was in sole charge of a section, whose sound practical judgment and engineering skill is widely recognised, and under whose care the younger man was placed for training, but who under the revision is graded as a chief inspector. In other words, the untried officer, whose engineering laurels are still to win, and who at the moment is under tutelage, becomes senior to his instructor.

It was the recital of cases of this type that apparently produced the feeling of bitterness so significant throughout the Conference. Speaker after speaker emphasised the apparent fact that by the application of no formulæ, rule, rhyme, or reason could the extraordinary results produced by the new classification be either harmonised or justified.

Other subjects were discussed which certainly deserve mention even in a brief editorial note. The steps taken by the Post Office Defence Committee in connection with the transfer were explained and endorsed; the recent reduction in the amount of the subsistence allowance and other matters were analytically examined and unanimously pronounced upon. But the Conference will unquestionably be remembered as the Conference of one theme, one resolution, one mind, and one decisive judgment, viz. that until the

Digitized by Google

"reorganisation" is reorganised and the new scales are given to every competent engineer, the Engineering Department of the British Post Office cannot experience either peace, efficiency or progress.

J. M. C.

FAST SPEED WHEATSTONE WORKING ON UNDERGROUND CIRCUITS.—Mr. F. C. C. Nielsen, of the Great Northern Telegraph Company, thinks it might interest the readers of the JOURNAL to know that the idea of the gumming up of the Morse and Wheatstone slip at transit offices was originally conceived in 1873 by the Company's late Superintendent at Newcastle, Mr. John Mygind, who at once saw the great saving of labour that was made possible by this means, and even had the slip gummed when the telegrams had to be transcribed. At the Company's Aberdeen office they copied for many years telegrams which were handed to the department from the gummed slip, but eventually handed over the gummed slips themselves, from which the telegrams were re-transmitted by the Post Office staff.

AS OTHERS SEE US.—The December number of our French contemporary, 'Annales des Postes, Télégraphes et Téléphones,' opens with a description of a visit for the purposes of study which was made by the students of l'Ecole Supérieure des Postes et Télégraphes to London in July, 1911.

A photograph and plan of the King Edward VII building is given, together with details of the various postal services at the General Post Office, Mount Pleasant, Western District and Chelsea. The article concludes with the following summary:

"The general impression which we derived from our visit to the postal service at London is that these services are provided with a numerous staff who work methodically, and in the second place, that the task of the staff is facilitated by well-arranged mechanical equipment so that the work proceeds smoothly, and with no trace of congestion. The organisation is such as to ensure that, whatever the intensity of the traffic, the despatch of correspondence goes on in a regular manner. One is struck with the order and propriety which prevails in the offices as well as with the good appearance of the officers. It is worthy of special note that excellent arrangements are made by the Post Office for the material wellbeing of its numerous staff. There is no doubt that the English Postal services are more liberally endowed than ours, but it must be remembered also that by the specialising of its staff, by the intelligent applica-

Digitized by Google

tion of the principle of division of labour, and by co-ordination of efforts, a very satisfactory revenue is obtained. The conveyors, travelling belts, 'facing tables' and the high-speed electric stamping machines which are liberally provided for the various services greatly facilitate the rapid execution of the work, and enable great economies to be realised as compared to manual labour."

D. H. K.

TYPEWRITERS IN THE TELEGRAPH SERVICE.—The Western Union Telegraph Co. of America have just purchased 10,000 Underwood Typewriters for the use of their staff.

In the United Kingdom Postal Telegraphs the typewriter has not yet arrived.

STATE TELEPHONES.—The January number of the 'Economic Review' contains an excellent article on "State Telephones" by John Garrett Leigh, which includes a review of Dr. Holcombe's work on 'Public Ownership of Telephones on the Continent of Europe.' We hope to deal with Dr. Holcombe's book in our July issue.

Digitized by Google

COUNCIL NOTES.

A New Class of "Associates"—Award of Medals for 1910–11.

On February 5th, 6th and 7th, the members of the Council met at Liverpool under the chairmanship of Mr. W. Slingo. A rather lengthy agenda faced the Council, who mustered in full strength to discuss it. The recent reorganisation, the new rating of officers, and the likelihood of a large increase in the membership of the Institution consequent upon the transfer of officers from the late National Telephone Company contributed somewhat to the volume of business, and also, no doubt, to the keen interest displayed on this occasion.

A meeting of the North Wales Centre having been fixed for the 5th, preceded by a visit to the British Insulated Cable Factory at Prescot, the members of the Council followed the usual custom of accompanying the local party on their visit, and attending the subsequent lecture in the evening, when a paper was read by Mr. J. Lockhart on "Wheatstone Working in Canada."

The business of the session opened with a discussion on the question of extending membership to the new classes of officers formed as a result of the recent revision. The importance of this matter and the hurried call of the Chairman to headquarters for a few hours decided the Council in holding over this item until all other business had been transacted. In the end it was agreed to make the following alterations to the rules: (1) That membership of the Institution be extended to the new class of officers known as Chief Inspectors; (2) that a new class of members be formed to be designated "Associates," who shall have all the privileges of full members except the power of voting, and that Senior Inspectors and probationary Sub-engineers be eligible for this class. As these proposals involved a re-drafting of the rules a sub-committee, consisting of Messrs Purves, Crawford, and Larner, was appointed for that purpose.

Amongst other items of business transacted was the Award of Medals for 1910–11. The result of the voting was as follows:

Mr. J. Sinnott, the Senior Silver Medal for his paper on "Fire Alarm Systems."

Mr. J. G. Lucas, the Junior Silver Medal for his paper on the "Life and Behaviour of Primary Batteries for Telephone Purposes."

Mr. A. S. Renshaw, the Senior Bronze Medal for his paper on "Methods of Statistics."

Digitized by Google

Mr. P. Dunsheath, B.Sc., the Junior Bronze Medal for his paper on the "Fundamental Principles of Modern Internal Combustion Engines."

The next meeting of the Council was fixed to be held at Nottingham on April 2nd and 3rd.

E. T. L.

LOCAL CENTRE NOTES.

METROPOLITAN CENTRE.

THE present session has been an unqualified success. The average attendance at the meetings, although always high, has recently shown a marked tendency to increase. This is no doubt largely due to the novel and interesting character of the papers read. It is equally gratifying to observe that the rule under which visitors are admitted to the meetings is being taken more advantage of by members than in the past.

During the session arrangements were made to distribute copies of the papers beforehand to intending speakers and also to report the meetings, so that the discussions, which are in themselves valuable, might be saved to the records of the Institution.

That our Institution is gaining in importance and looming largely in the public eye is seen by the fact that the 'Times' and the technical press generally consider it desirable to publish lengthy reviews of our papers. And this has the effect of bringing requests for copies from a place so far afield as Chicago. In one case a representative of the Commonwealth of Australia has requested a copy of the paper in order to place it at the disposal of the Australian Postmaster-General.

Sir A. F. King, Secretary to the Post Office, honoured the meeting of February 12th with his presence, when Mr. Martin read his paper on "The Economics of Telephone Transmission," and Mr. A. M. Ogilvie, C.B., the Secretary in charge of the Telephone Department, was present to hear Mr. B. O. Anson read his very instructive paper on "Machine Switching in Telephony" at the meeting of February 26th.

Both Sir A. F. King and Mr. Ogilvie paid generous tributes to the work of the Engineering Department, and to the educational value of the Institution to its members.

The present session has now practically closed inasmuch as Mr. Kempe's paper on "Telegraph History" will have been given before these lines are in print, and only the Annual General Meeting

Digitized by Google

will remain to be held on April 22nd. In these circumstances a cordial invitation is given by the Metropolitan Committee through the pages of the JOURNAL to members of the Institution to give papers next session.

The high level of success reached demands an even greater effort in the future, so that our Institution may continue to be recognised as a potent factor in the scientific world.

Unfortunately it has not been found possible to carry out the programme of visits as originally arranged. In the case of the National Physical Laboratory the serious illness of the Principal, which occurred in the autumn, has rendered a postponement inevitable, and the visit will now take place on a Saturday afternoon in May or June.

The proposed visit to the Thames Ironworks has also had to be postponed on account of events in connection with that Company's affairs, which have been made public and do not therefore require any further explanation.

On the other hand, a very interesting visit was paid to the New Avenue Exchange on February 7th. That this visit was highly successful is due to arrangements which were made by Messrs. Noble and Preston for the reception of the members. A party of fifty was conducted over the Exchange by Mr. D. H. Kennedy.

Upon going out of office the Metropolitan Committee desire to place upon record their appreciation of the services rendered to the Centre by the Chairman, Mr. J. M. G. Trezise, and the Vice-Chairman, Mr. E. Gomersall. These gentlemen have worked earnestly to secure the continued welfare and prosperity of the Metropolitan Centre.

ENGINEERING DEPARTMENT CHESS CLUB.

"Let not the grass grow on the path of friendship."

On February 19th, at the Holborn Restaurant, was held the Eighth Annual Social Re-union of the Engineering Department Chess Club. The function, which consisted this year of a dinner followed by a smoking concert, was rather a more elaborate one than the Chess Club has hitherto attempted, but the success which usually attends the social functions of the Club was fully maintained. About 130 people were present, amongst whom were many ladies and many of our new colleagues of the late National Telephone Company. Major O'Meara presided.

The speeches and toasts were few. Mr. R. A. Wells (Captain), in reply to Major O'Meara's encomium on the social activities of the Chess Club and toast, stated that it was a great pleasure to the

Digitized by Google

Club to arrange these functions and dispose of the idea that chess was entirely unsociable, that the club was in a flourishing condition financially, and that it was rendering a good account of itself in the First Division of the Civil Service League. Mr. A. Watts, who proposed "The President," first referred to the cordiality with which he and his colleagues of the late National Telephone Company had been received by their new colleagues, and then went on to eulogise the services of Major O'Meara to the Engineering Department and his keen interest in the betterment of all classes in his Department. The toast was received with musical honours. Major O'Meara, who was visibly moved by the warmth with which the toast was received, briefly replied.

The musical programme was excellent, and the formality and stiffness that so often attend functions of this nature were entirely absent on this occasion. The Committee is to be warmly congratulated on the success of the evening.

Whist Drive.

On February 3rd, at Tiffin's, Cheapside, the Chess Club held a whist drive.

The Drive was well attended, there being 150 people present, and a very pleasant evening was spent by all.

SOUTH-WESTERN CENTRE.

The session was opened in October with visits of inspection to the Bristol Docks at Avonmouth, and the Canadian liner "Royal Edward."

The Central Power Station of the Bristol Corporation Electric Light Department was visited later in the day.

In November Mr. R. Bradfield read a paper on the "Theory of C.B. Telegraphs," for which he had received the President's prize, and his mathematical treatment of the subject was keenly followed and appreciated.

On December 11th, Mr. E. A. Pink repeated before his new colleagues the paper on "Distribution by Parallel Cables" which he had contributed to the Metropolitan Centre a few days previously. This paper has received appreciation from the technical press.

Mr. W. S. Mountain visited Bristol on January 30th and before a large gathering reviewed the various intepretations which had been put upon the several clauses of the Department's Contract Specifications and explained the official meaning.

Digitized by Google

On March 4th Mr. H. A. McInnes, of Oxford, was welcomed by his friends and former colleagues in the South-Western District, who were greatly interested in the progress of the extensive work "Remodelling of the Irish Telephone Line between Rickmansworth and Broadway."

This work involves a considerable departure from present standard practice, and will doubtless receive fuller treatment in the JOURNAL at a later date.

The present session is proving very successful, and with three meetings yet to come promises to create a record for this Centre. The local committee have been much encouraged by the large attendance of clerical officers at recent meetings.

SCOTLAND EAST CENTRE.

On December 20th, 1911, Mr. B. J. Gill read a paper on "Records." Mr. Machugh, superintending engineer, presided over a good attendance of members.

Mr. Gill dealt mainly with the principal books used in the Plans and Records Section of the Superintending Engineer's Office, and indicated that in his opinion the present system of records had tended to become too much elaborated. During the ensuing discussion, however, it was made clear that in the opinion of the majority of both Engineering and Clerical Officers present, the existing records were the minimum necessary for reliable working and ready reference.

A vote of thanks was accorded to Mr. Gill for his paper.

The fourth meeting of the Centre took place on January 17th, 1912, when Mr. Machugh, Superintending Engineer, lectured to an interested audience on "Submarine Work." Mr. C. Crompton, Assistant Superintending Engineer, presided.

Mr. Machugh described fully the method of repairing faulty cables, the uses of cable buoys and mushroom anchors. He specially pointed out that great care should be taken in carrying out tests after repairs, and that at each cable hut a record should be made of the length of coil available at the shore end for service in the event of the cable becoming faulty. On conclusion of the lecture Mr. Machugh was especially thanked, and also Mr. Crompton for his services in the chair.

The Third Annual Whist Drive and Dance was held in the Carlton Hotel, Edinburgh, on Wednesday, December 20th, 1911. Sixty-four ladies and gentlemen were present. Mr. and Mrs. Machugh received the guests, amongst whom were Mr. and Miss Campbell,

Digitized by Google

Mr. and Mrs. Eden, and Mr. and Mrs. Crompton. Mr. Campbell, late Superintending Engineer, presented the prizes to the winners—Mrs. Gill and Mr. Robertson, first prizes, and Miss Campbell and Mr. Machugh, second prizes. After the whist drive a most enjoyable dance and musical programme was carried through, at the close of which Mr. Crompton, in an appreciative speech, thanked the artistes for their services.

The Annual Dinner of the Scotland East District took place on January 17th in Fergusson and Forrester's Restaurant, Princes Street, Edinburgh. Mr. Machugh, Superintending Engineer, presided, ably supported by Mr. Crompton, Assistant Superintending Engineer. Eighty-five gentlemen attended. Amongst the guests were Mr. Campbell and Mr. Eden, late Superintending Engineers, Scotland East District, Mr. W. Smith, Controller of Telegraphs, Major Brisbane, Accountant's Office, General Post Office, and Mr. Reeves, Representative in Edinburgh of the Controller of Stores. Mr. Allen represented the Secretary's Office (Edinburgh), and Mr. G. Fleming the Scotland West District. There were also visitors from the Office of Works and Inland Revenue. Mr. McIntosh, District Engineer, and a number of other officials of the late National Telephone Company were present, but Mr. Worte, the District Manager, was unable to attend.

The toast of the "Engineering Department" was proposed by Mr. Reeves. Mr. Crompton responded in an excellent speech dealing with the growth and progress of the Engineering Department during the past decade, and his reference to the high standard of the work performed by the clerical staff was greatly appreciated. Mr. Slader proposed the toast of "The Commercial Branch" in a humorous and characteristic speech, and Mr. Jefferyes, in charming style, that of "The Visitors." An excellent musical programme was carried through and a very successful dinner was brought to a close by the singing of "Auld Lang Syne."

EASTERN CENTRE.

The third meeting of the Session was held at Cambridge on the afternoon of Tuesday, January 9th, 1912, when a paper entitled, "Staying a Telegraph Line," was read by Mr. T. Cobbe.

Mr. Cobbe explained that for the purposes of his paper he intended the word "staying" to include any device having for its object the strengthening of a line above what would be required if ideal conditions obtained, the adoption of this wider meaning

Digitized by Google

enabling him to compare the various methods adopted for adding stability to a line as regards cost, efficiency, appearance, etc.

The lecturer had prepared a comparative schedule, setting forth the costs of the various methods of support usually employed, and also their relative efficiencies, it being assumed that in each case a 40 ft. pole carrying a maximum of fourteen arms was concerned.

The advantages and limitations of the various methods of strengthening a line were considered, the paper, which was illustrated by some excellent diagrams and photographs, concluding with descriptions of some special and peculiar stays not described in T.I. 13.

The fourth meeting took place on the afternoon of February 6th, 1912, when a paper on "Faults" was read by Mr. W. Scarr.

The subject being altogether too wide to be dealt with comprehensively in the time at his disposal, the lecturer confined his remarks principally to the more common causes of stoppage and delay to communication, dealing with the matter under the following headings:

Classification—non-preventable and preventable faults.

Causes and precautions.

Percentages based on the Eastern District returns for the past year.

"Unknown" faults—some examples.

Distance between testing points.

Subscribers' complaints.

The Quarterly Returns—a criticism of.

Both papers proved very interesting and were well discussed, there being good attendances on each occasion.

The Annual Dinner of the Eastern District took place at "Ye Olde Castel Hotel," Cambridge, on the evening of February 6th, 1912.

About fifty members of the staff attended, including several of the local Ex-N.T. Co. officials. The chair was occupied by Mr. J. F. Lamb.

A good musical programme had been arranged by Mr. W. H. Cowley, and a very pleasant evening was spent.

SOUTH WALES CENTRE.

On December 12th, 1911, the South Wales Centre met, under the Chairmanship of Mr. R. McIlroy, to hear Mr. E. D. Careless read his paper on "Wayleaves." Many interesting points were raised, and these subsequently gave opportunity for an instructive discussion.

Digitized by Google

Mr. J. Martin, Assistant Superintending Engineer, contributed a paper on "Maintenance and Faults" at the meeting held on January 9th, 1912. A good attendance of members showed its appreciation of the lecture in the very interesting discussion which ensued.

On February 13th a paper on "Office Organisation and Equipment" was read by Mr. P. E. Milford before a large gathering of members. The paper was characterised as describing an "ideal" condition of things which would be very acceptable to the service generally.

NORTH-EAST CENTRE NOTES.

On Wednesday, December 6th, a visit was received from Mr. W. S. Mountain, of Headquarters, who read an interesting paper on "Departmental Contracts." The various clauses and conditions of Form E-in-C. 137 were exhaustively dealt with and the reason for their existence explained. A vigorous discussion followed the reading of the paper, particularly with regard to the desirability or otherwise of putting out to contract work that could be performed by men directly employed by the Department.

The lecturer was most emphatic in his statement that opinion at headquarters was wholly in favour of putting work out to contract. It was contended that the contractor could quote rates with which the Department could not hope to compete.

A meeting had been arranged for January 15th, but owing to the regretted illness of Mr. T. B. Johnson the meeting had to be postponed until February 5th. On this date Mr. Johnson favoured us with a paper entitled "Some Notes on Aërial Construction." In the course of the paper a number of points, which are in great danger of being overlooked, were dealt with in a most interesting fashion, and the very practical nature of the "notes" enhanced the value of the paper.

The subsequent discussion revealed the keen interest aroused.

On February 26th Mr. W. G. Medlyn, of Manchester, read a paper of great practical interest entitled "Localisation of Faults in Dry Core Cables." The lecturer's long experience in cabling operations in several districts enabled him to give much information of great value to all engaged in this class of work, and many timely hints to those who so far have had no such experience.

Digitized by Google

LIBRARY NOTES.

THE following books have been added to the Library, and are available for the use of members:

No.

196. 'Manual of the Telephone.' W. Aitken.

197. 'Application of Hyperbolic Functions to Engineering Problems.' A. E. Kennelly.

198. 'India Rubber and its Manufacture.' H. L. Terry.

'Applied Mechanics.' A. Jamieson.

43. Vol. i: 'Applied Mechanics.'

44. Vol. ii: 'Strength of Materials.'

45. Vol. iii: 'Theory of Structures.'

47. Vol. v: 'Theory of Machines.'

755. 'House and Town Planning; Conference of Institution of Municipal and County Engineers, July, 1911.'

754. 'Institution of Mechanical Engineers,' Proceedings 1910 and 1911.

753. 'Journal of the Manchester School of Technology,' vols. iii and iv.

LONDON TELEPHONE SOCIETY.

The Telephone Society of London held a very successful meeting at the Hall of the Institution of Electrical Engineers on February 7th, when a paper on "The Advance of Automatic Telephony" was read by Mr. E. A. Laidlaw, of Messrs. Siemens Bros. & Co., Ltd. Mr. Laidlaw was until comparatively recently a member of the Engineer-in-Chief's staff of the National Telephone Company.

The meeting is noteworthy on account of the presence of the Postmaster-General.

Mr. Laidlaw pointed out that it is now perfectly practicable to set up telephone connections by means of automatic apparatus, and that he had purposely avoided a detailed description of apparatus and circuits. He had considered the subject from the service and economic standpoints. Some slides were, however, shown of the different pieces of mechanism that go to make up an automatic system. A short description was given of the preselector, which replaces the Keith line switch in the Siemens adaptation of the Strowger system. The author answered the question, "Will the automatic system render satisfactory service?" by taking the various factors that are involved and considering each in detail as affected by

Digitized by Google

the automatic apparatus. Some of the points touched upon were—accuracy, speed, errors, reliability and transmission. The difficulties introduced by varying rates, junction fees, postal facilities, inquiries and complaints were also considered at length. The need for very great care in making traffic studies and in the design of the equipment to ensure sufficient trunks being available at all times was emphasised.

The question, "Will the automatic system pay?" was next considered, and comparative costs obtained from actual working exchanges were given. The author had gone to a great deal of trouble in collecting the information, and had attempted to consider the question from a purely impartial standpoint. In order to make a comparison on general lines a typical area was considered, and the costs of installing manual and automatic systems compared. The saving in annual charges by introducing automatic plant was shown to be considerable. The paper concluded with a brief reference to the semi-automatic system.

The author dealt with the subject in a very thorough and fair manner, and his figures were far more convincing than any others so far published.

The discussion was opened by the Postmaster-General, who made reference to the policy of the Department in regard to automatic equipments. He stated that capital for the extension and improvement of the telephone service as a whole would not be stinted.

Mr. Gill, Engineer-in-Chief of the National Telephone Company, spoke next, and said that telephone engineers wished to get at the truth in this matter, but facts were very hard to obtain. Generalisation was of no use; he considered that the proper thing to do was to first investigate results on the spot in places where the automatic system was already working, and, if the investigation was favourable, to prepare estimates and study the system as applied to home conditions. Experimental installations should be tried on the Administration's own staff. He congratulated Mr. Laidlaw on omitting any reference to 10 per cent. trunking, and asked whether switches could be constructed to hunt over 80 or 100 junctions, such as a group between London Wall and Gerrard Exchanges. He considered that the loss of control due to the abolition of the operator was a very serious matter.

Mr. Dalzell, Superintendent of Post Office Telephones, raised points concerning the method of charging for junction calls, and criticised the cost figures. He asked whether the author could give him the name of any up-to-date central battery system which had been replaced by an automatic system.

Mr. Ogilvie, Secretary of the Post Office, spoke next, and mentioned how rapidly initial troubles, due to the mis-handling of the

Digitized by Google

automatic apparatus by subscribers, were overcome in practice. He thought that the methods of design on the basis of probability calculations as laid down in the paper should adequately meet the difficulties due to the lack of elasticity of the automatic system as experienced in the past. A feature of the service which appealed to him particularly was its evenness. He thought that the adoption of the automatic system would simplify the rate question on account of the small variation of the cost with the volume of the traffic.

Mr. Cohen followed, and expressed the opinion that difficulty would be experienced when the boundaries of the exchange areas had to be extended. For instance, the boundaries of the London area might very probably be extended to include Windsor and Reading. He exhibited a slide showing combined allowances for Western Electric Company's No. 1 C.B. Exchange circuits and Siemens & Halske's automatic system, showing a considerable gain in the case of the automatic system.

Mr. Napier wanted more specific figures regarding the percentage of irregularities quoted in the paper. He discussed the question of junction fees, and thought that the tendency would be to introduce still wider differences instead of having a uniform fee, as suggested in the paper.

Mr. Laidlaw, in his reply, disposed of all the points raised in a satisfactory manner.

The discussion was continued at a subsequent meeting held on March 6th, when Messrs. L. T. Horne, Stirling, Parker, Stewart, and Pink spoke. On the same evening Mr. Conrad Fuller gave a very lucid description of the principles of the automatic system, and showed some very simple circuit diagrams, and his short paper was of considerable assistance to many of the audience. A quantity of automatic apparatus kindly lent by Messrs. Siemens, Bros., was on view each evening.

BATH TELEPHONE SOCIETY.

THE fourth meeting of this Society was held on the 17th instant, with Mr. Walter C. Owen, Vice-President, in the chair, and practically the full membership in attendance.

An illustrated lecture was given on "Transmission" by Mr. T. O'Connor Parnell (Chief Inspector), explaining the elementary rules governing the transmission of speech waves and the improvements effected by scientific loading. A cordial vote of thanks was accorded the lecturer for the happy manner in which instruction and interest had been combined in dealing with his important and highly technical subject.

Digitized by Google

CORRESPONDENCE.

To the Editor of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

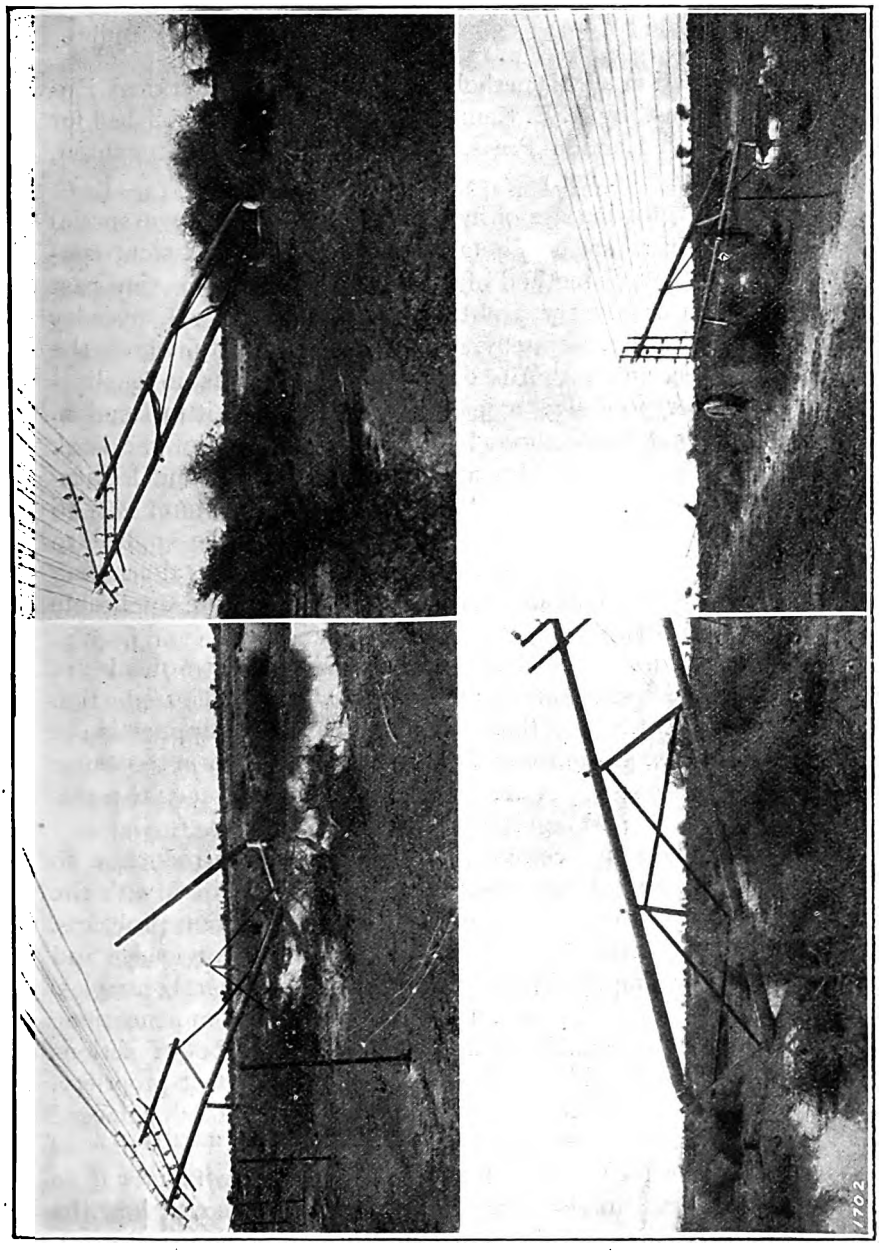
DEAR SIR,—On September 31st, 1911, a severe cyclonic storm occurred near Raewind, about twenty-four miles from Lahore, and completely wrecked twenty-three coupled telegraph posts. It was very local and did no damage to the posts on either side of the wrecked ones, nor was any damage done to villages or buildings on either side of the track of the storm. The line consisted of B.C.D. Hamilton standards coupled and braced, and carrying nineteen wires on eight-in-a-row angle iron brackets. These standards are made up of sheet-iron tubes rolled to a standard taper so that they can be easily fitted together on the spot, a cast-iron socket being used for the base. The strengths of the various tubes are so arranged that the safe working load of any post, of which the top tube is a "B," is always the same whatever its height may be. In this case the posts were B.C.Ds., the safe working load of which is a pull of roughly 400 lb. applied at the top of the post. The posts were, however, coupled and braced, which more than doubles the strength of the line. These posts, therefore, should have safely withstood a pull of considerably over 800 lb. applied at the top. This will give some idea of what the strength of the wind must have been.

I enclose some photographs showing the extent of the damage done, which may be of interest.

Yours faithfully,

CALCUTTA. W. SUTHERLAND.

Digitized by Google



AN INDIAN BREAKDOWN.—REMARKABLE EFFECTS OF A CYCLONE.

Digitized by Google

BOOKS RECEIVED.

'The Application of Hyperbolic Functions to Electrical Engineering Problems,' by A. E. Kennelly, M.A., D.Sc. (Published for the University of London Press, Ltd., by Hodder & Stoughton, London. 273 pp. 6s. net.)

Owing to the growing use of hyperbolic functions in some special branches of electrical science, notably telephonic transmission, considerable interest in this method of calculation has for some time past been aroused in this country, and this culminated in the University of London inviting Dr. Kennelly, of Harvard University, who is the recognised pioneer and authority on this subject (at least in English-speaking countries) to deliver a series of lectures upon it in London. The result was that five lectures, forming the substance of the book before us, were delivered in May and June last year, at the Institution of Electrical Engineers. The object of the lecturer was to show how hyperbolic functions can, with advantage, be applied to electrical problems, both in connection with steady, and alternating currents, and that formulæ of the same general form are applicable to both steady and alternating current problems.

The book is divided into ten chapters, in addition to a number of appendices. The first chapter contains a mathematical introduction to the subject, and the next three chapters treat of the application of hyperbolic functions to continuous current lines of uniform resistance and leakance in the steady state, equivalent artificial circuits to represent any actual line, and regularly loaded uniform lines.

Chapter V deals with complex quantities as an introduction to alternating current work, and the remaining chapters deal with the applications of hyperbolic functions to alternating current problems, including power transmission, telephone transmission on loaded and unloaded lines, telegraphy, and finally miscellaneous general examples.

Such a book, written by such an author, needs no commendation; indeed, to praise Dr. Kennelly as an exponent of hyperbolic functions were to gild refined gold; still, one may, with perfect propriety, ask: What is its value to the telegraph and telephone engineer? Will it simplify his work or give him greater scope? The writer of this article thinks its value is great, and to those who intend to seriously study transmission Dr. Kennelly shows, moreover, how the use of the functions in certain cases simplifies calculation. For example, in Chapter VI, pages 78 and 79, we have the case of a relatively short disconnected line with a potential wave traversing it, and being repeatedly reflected from end to end. It is shown that the sum

Digitized by Google

of the required effects may be expressed by E Sech θ, where E is the initial, E M F and θ the complex line angle. Knowing θ, its "Sech" value may be directly read from a suitable table, and there can be no simpler way of obtaining this complex result. This result is typical of many others. It cannot be said, however, that the same result could not be obtained without the use of hyperbolic functions, and some well-known writers who are aware of the claims of hyperbolic functions do not use them. If, however, one wishes to keep up with modern transmission literature, it is absolutely necessary to understand this method of calculation, and its use is certain to extend. By the bye, it is not very difficult for those who have a competent knowledge of the usual trigonometry and algebra necessary for alternating current engineering problems, to obtain a quick and ready grasp of the method of applying hyperbolic functions. The formulæ in trigonometry are so similar to those in hyperbolic functions that if the one is known the other can easily be remembered. Dr. Kennelly gives a comparative list of such formulæ in Appendix B, and this is very helpful.

An interesting feature of the book is the bibliography at the end. One is glad to have these references, but—alas! there is a but—although Dr. Kennelly tells us that the bibliography is necessarily imperfect, one notices important omissions, and is naturally surprised, for example, to see Dr. Bresig's 'Theoretische Telegraphie,' published in 1910, not included. This book covers the whole range of transmission and is an accepted standard work. Perhaps Dr. Kennelly will include this and some others in a future edition.

Finally, although the book requires an advanced standard of knowledge to completely understand it, it is a valuable exposition of an important subject, and demonstrates that hyperbolic functions constitute a powerful means of research.

The electrical profession generally is under a debt of gratitude to Dr. Kennelly.

The book is excellently printed on good paper and is well and artistically bound. J. G. H.

Aitken's 'Manual of the Telephone,' by W. Aitken, M.I.E.E. ('Electrician' Publishing Co., Salisbury Court, Fleet Street. 18s. net.)

Mr. Aitken's book of the telephone, which has been some years in preparation, contains 26 chapters, 674 pages, and 600 illustrations, a considerable number of the latter being folding plates.

The volume deals almost exclusively with internal telephone plant as used at exchanges or subscribers' stations, and a number

Digitized by Google

of important subjects, such as construction, traffic and operating, maintenance and testing, etc., are relegated to a second volume which will appear at some future date.

At the present stage in telephone history, when progressive engineers are laboriously acquiring acquaintance with automatic switching machinery, some words from Mr. Aitken's preface are peculiarly appropriate and worthy of reproduction:

"Those who have been interested in the industry from near its origin must have been impressed by the necessity for frequently changing front and surmounting new difficulties in the shape of new systems, which, as the years progressed, have become more and more intricate and elaborate, until it is now almost impossible to keep in touch with all the ramifications.

"It is necessary to specialise in certain directions. The man who has not taken an active part in the business for a few years is hopelessly antiquated.

"It can, I think, be safely said that in no other department of engineering has such an infinite mass of detail to be mastered, or is there such scope for ingenuity and originality as in telephone engineering. In addition to telephone work proper, the engineer must know a good deal about power and lighting, as although the current used for talking and signalling is small for each line, yet for a large exchange very special dynamos with an output of 1000 ampères at 30 volts will be required, with associated motors, accumulators, cut-outs, switches, meters, etc.

"He must also know a good deal about trenching in streets, building conduits, and manholes, nature of soils, road surfaces, building construction and materials, and if a mathematician, he will have transmission problems, loading lines by Pupin coils, self-induction, and capacity testing of circuits and apparatus."

After a preliminary elementary introduction and some valuable and interesting historical notes, Mr. Aitken deals exhaustively with receivers and transmitters. Several chapters are devoted to magneto systems, and most readers will probably think that too much space has been allotted to apparatus and systems which are either obsolete or obsolescent. When, however, we find that the same exhaustive treatment has been given to modern systems, we are inclined to withdraw any objection, and to realise, on one hand, the magnitude of Mr. Aitken's task and the thoroughness with which he has accomplished it, and, on the other hand, that since any exhaustive work on telephony must necessarily require a long time for its production, it is impossible in dealing with an art so progressive as telephony to keep absolutely up to date. The diagrams and illustrations of modern exchanges are well selected and well reproduced, and the chapter on lay-out and wiring is exceptionally good. Small switchboards receive adequate treatment, as also do power plant and trunk line exchanges. The last chapter and the last hundred pages are devoted to automatic switching systems, on which

Digitized by Google

subject Mr. Aitken is an acknowledged authority. Here again the treatment is exhaustive, all the modern systems being carefully reviewed. The book will undoubtedly have a high value as a reference manual, and every telephone engineer who can afford the somewhat prohibitive price will include it in his library.

D. H. K.

'The Radio-Telegraphist's Guide and Log Book,' by W. H. Marchant. (London: Whittaker & Co., 1912. Price 4*s.* 6*d.*)

This is a compact and useful-looking little book, well illustrated, and of a size convenient for the pocket. It is intended to be of service to the practical operator, and, as such, gives a sound exposition of the main principles without being discursive and without entering deeply into the theory of the subject.

The Poulsen system is fully described in relation to key speed working. The devices for high speed reception are included, but the high speed transmitting appliances are not explained.

The Lepel system receives a full share of attention with numerous illustrations, and includes a description of the method of variously changeable musical note transmission.

The Lodge-Muirhead, the Telefunken Quenched spark and other prominent systems also receive due notice.

Chapter VI commences with the description of a device, said to be due to the author, for eliminating atmospherics or "strays." A differential method of receiving is involved which calls at once to mind the Fessenden interference preventer. The utility of such contrivances, unless used in a very special manner, is, however, a doubtful quantity.

The Telephone Relay of Mr. S. G. Brown is also fully described and dwelt upon at some length.

The penultimate chapter on measurements is an attractive, though necessarily brief, portion of the book.

From the operator's point of view it is thought that a little more detailed explanation of the power machinery would be useful, even if at the expense of some of the descriptive matter relating to receiving devices.

Attention is called to errors in the code call letters of British Coast Stations in Appendix VI. The initial letter M should, in each case where it occurs, be replaced by the letter G. This alteration came into effect when the coast stations were acquired by the Postal Telegraph Department.

A number of log sheets for the use of operators, arranged for

Digitized by Google

recording signals received together with their characteristics and other observations, forms a special feature of this book.

Altogether the book should be quite useful for the purpose for which it is intended, viz. to assist operators to obtain a sound grasp of the principles and practice of wireless telegraphy.

J. E. T.

'Practical Electrician's Pocket Book and Diary, 1912.' (Rentell, cloth 1*s.* net; Rexine (with insurance), 1*s.* 6*d.* net.)

This annual for 1912 has some novel features which have been incorporated, in addition to the usual revision of existing sections, by independent experts.

Progress in electrical matters is indicated by the expansion of the list of central stations, and accompanying names of the engineers-in-charge. This list has grown, during the twelve months, by little short of three pages.

The section dealing with the Diesel engine has been re-written, and now includes some excellent diagrams, showing the relative efficiencies of steam, gas and Diesel engines, which, naturally, redound to the credit of the last named. Another important section, that relating to producer gas, has also been revised and enlarged. Other sections which have undergone special revision and modification are those dealing with petrol engines; comparative costs of electric light and power (the latter now including load and factor tables); motor controllers; electricity meters (additional diagrams of connections); wiring systems, which now include such modern innovations as Woodhouse casing, Henley's new system, Stannos revised instructions, etc.; and measuring instruments, embodying particulars of the "ducter" and "ampall."

Among the entirely new sections of the 1912 pocket book is a complete and practical treatment of the subject of bioscope working, illustrated by clear diagrams.

The pocket book also contains a useful table of depreciation allowances. Telephone equipment is put down at 8-10 per cent. Another topical subject at the present time is illumination, which has also been specially treated; whilst electric railway employees will find their requirements met in the new and up-to-date section under this heading, contributed by W. A. Agnew. The switchboard section has been augmented by an illustrated sequel devoted to mining switchgear.

'The Electrical Engineers' Diary,' published by Messrs. S. Davis & Co., 30 & 31, St. Swithin's Lane, Bank, E.C. (2*s.* 6*d.*), gives a large amount of information specially useful to consulting and central station engineers, contractors, and the electrical public generally. London engineers will find the section giving all the streets in London, the supply authorities in each street, the voltages, prices charged, and special regulations of great assistance in carrying out their work.

Digitized by Google

The Power Section gives valuable details as to the requirements and best means of meeting them for a large number of special trades.

The technical data is well arranged, and the book is clearly printed.

The diary section is on squared paper, and interleaved with blotting-paper of specially good quality.

'Questions and Solutions in Telegraphy and Telephony, Ordinary Grades,' by H. P. Few. (S. Rentell & Co., 36, Maiden Lane, W.C. Price 2*s.* 6*d.* net.)

A third edition of this useful handbook has recently been published. The author, Mr. H. P. Few, of the Engineer-in-Chief's Office, is to be congratulated on the lucidity of the solutions, also on the clearness of the various diagrams. The latest edition contains answers to the questions set by the City and Guilds of London Institute at the examinations set in 1910 and 1911.

The book will prove of great assistance to students preparing for technical examinations.

'The Universal Electrical Directory' (J. A. Berly's), 1912. (Publishers: H. Alabaster, Gatehouse & Co., 4, Ludgate Hill, E.C.)

This edition has been carefully revised, and no pains have been spared to make it accurate and reliable.

The contents are divided into four sections: British, Colonial and General, Continental, and U.S.A. with 34,485 names, although unimportant entries are omitted. Each section is sub-divided into alphabetical and classified sections, while in the case of the British a geographical section has been added, which is a necessity for all travellers. Any section can at once be referred to by means of a thumb index.

A feature, which has been repeatedly asked for, is the separation of the London from the provincial names, in the British alphabetical section.

Telegraphic addresses, telephone numbers and codes are given in the alphabetical sections, financial particulars of British limited liability companies, also of foreign companies with a British address.

The lists of electricity undertakings in the United Kingdom, British colonies and some other countries include the following details: the nature of the supply, system of distribution, capacity of plant, voltage, and chief engineer's name, and in the case of alternating current, the phase and periodicity are included.

A list of specialities appears in the British section arranged alphabetically according to the name of the article, followed by the

Digitized by Google

maker's or agent's name and address. This, judging by inquiries, should supply a present-day want.

The price of the Directory is 14*s.* 6*d.* post free, or the "A" edition, containing the British and Colonial and General Sections only, is 10*s.*, also post free.

Review held over for next issue:

'The Public Ownership of Telephones on the Continent of Europe,' by Dr. A. N. Holcombe. (London: Constable, 1911. xi+482 pp. 8*s.* 6*d.* net.)

WIRELESS PATENTS.

The following is an extract from an article appearing in the January issue of 'The Marconigraph,' which sets out the present position of affairs in regard to patents for wireless telegraphy:

"Proceedings at law have been commenced in New Zealand by Marconi's Wireless Telegraph Co., Ltd., against Huddart Parker, Ltd., for infringement of the Company's patents by the use of the Telefunken system of wireless telegraphy on board some of their ships plying between Australia and New Zealand. Instructions have been cabled to commence similar proceedings in Australia against the same firm and the Australasian Wireless Co., who supplied the plant.

"The Helsby Wireless Telegraph Co., Ltd., having applied for a licence to work under the extended patent granted to Sir Oliver Lodge, and now the property of the Marconi Co., the Board of Trade appointed Sir Cornelius Dalton, late Comptroller-General of Patents, as arbitrator. The hearing commenced on December 11th and is still proceeding.

"Messrs. Siemens Brothers & Co., Ltd., the assignees in this country of the Telefunken system of wireless telegraphy, have also applied for a licence to work under this patent, and are assisting the Helsby Company in the arbitration proceedings. It is contended on behalf of the applicants that they cannot work any system of wireless telegraphy without a licence under the patent in question.

"The Helsby Wireless Telegraph Co., Ltd., have installed the system on four of the ships of the London & North-Western Railway Co., and the original application was for a licence for these four ships, but upon the submission of the blue prints of the actual installations, the Marconi Co. contended that their No. 7777 patent was infringed; the arbitrator is therefore asked to define the terms of a general licence, excluding these four ships, in respect of which other proceedings will be commenced.

"The Marconi Co. are determined to protect their rights under their

Digitized by Google

patents in all countries, and legal proceedings are pending in respect thereof in France, Spain, and the United States of America.

"Great pains seem to have been taken to publish on the Continent and in the Colonies the fact that Marconi's Wireless Telegraph Co. have withdrawn an action commenced against Messrs. Siemens Brothers & Co. in respect of the Telefunken patents. Our readers will be interested to know what are the facts of the case.

"On October 20th last the Marconi Co. issued a writ against Messrs. Siemens Brothers & Co. for infringement of their patent No. 7777. On the following day it was determined to sue Messrs. Siemens in respect of infringement of another patent, and therefore a new writ was applied for, embracing both the four sevens patent and the other one. It being obviously useless to proceed with two actions for infringement of the same patent, the writ No. 1 was withdrawn, but the action for the infringement of the patent with which it dealt is continuing under the writ issued on October 21st.

"The communication of such information to the Government of the Commonwealth of Australia was immediately followed by a report that the Commonwealth Government has discontinued the contract which it entered into for the erection of stations under the Telefunken system."

ABOLISHING POSTAGE STAMPS.

To the Editor of 'The Scientific American.'

In your issue of August 19th last, on page 169, under the heading of "Abstracts from Current Periodicals," there is a reference to "abolishing postage stamps," and it is quoted that in Bavaria since February 1st, 1910, large consignments are simply stamped with a postmark at the post office, the operation being carried out by machinery. The practice of stamping in this manner has been in vogue for many years in the Dominion of New Zealand, and what is more, for the past six years the postal authorities have permitted the use of automatic stamping machines, and they are now almost indispensable in every business in the Dominion.

The machines are purchased by the user, being certified and sealed by the department before going into use. All documents requiring stamping, such as postages, receipts, telegrams, drafts, bills of exchange, bills of lading, etc., are stamped with the necessary values by the machine. Periodical readings are taken by the postal department, and payment made on a debit note.

The advantages to the department are the saving in cost of manufacturing postage stamps and the clerical labour in the issue of stamps, while the advantage to the commercial man is the absolute protection against peculation by the office boy, whose opportunities while in charge of the petty cash for postages are unfortunately taken advantage of to an extent only too well known by the whole commercial world.

Digitized by Google

Stamping machine impressions are not negotiable, as in the case of postage stamps. Wrong additions in the postage book, overcharging postages, abbreviating telegrams, etc., can avail the office-boy nothing, because he has to manufacture his postages, etc., as he requires them, and being without petty cash he is perforce kept honest.

He certainly might venture upon the sale of a few stamped envelopes, but detection is swift, because each machine has a number which is recorded at the post office, and impressions are traceable to the office of origin in a few minutes.

The protection against fraud on the government is absolute. There are thousands of mechanics in the world who could forge postage stamps and dispose of them; they could certainly forge the stamping machine impressions, but their labour would be in vain because there is no monetary value in it.

The list of users and the testimonials which I enclose are a striking testimony of its value in our Dominion.

Christchurch, New Zealand, W. H. E. WANKLYN.

'Scientific American,' *January 20th*, 1912.

NOTES FROM NEW YORK.

The Plant Department in the Jersey City District has just completed stringing wire for six new circuits to be used for long-distance connections. These circuits are of No. 12 wire, they are all phantomed, and both the phantom and physical circuits are loaded. They are to be used for connections between New York, Rochester, Scranton, Wilkesbarre, Buffalo, and Elmira.

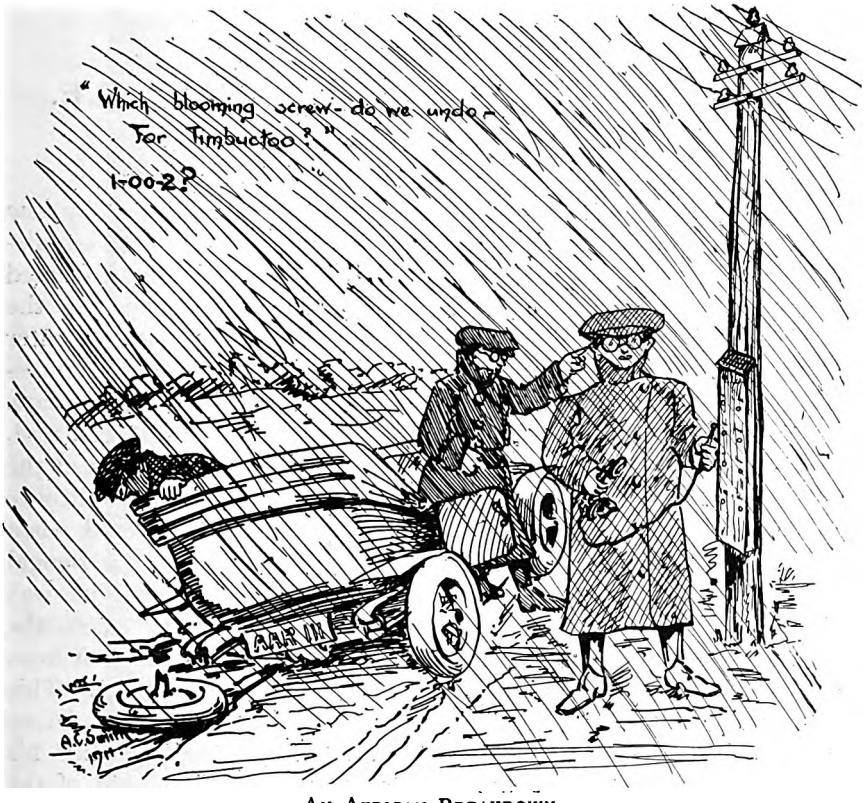
The Commercial Department has recently taken a contract for a telephone to be installed on a float in New York Bay. In order to make this connection it will be necessary for the Plant Department to set poles from the shore to the deep water channel and from this point to run a submarine one-pair cable to the float where the telephone is to be installed.—*Telephone Review.*

Digitized by Google

AUTOMOBILE TELEPHONE SERVICE IN THE U.S.

THE latest victim to be roped into the ever-widening telephone system of the States is apparently the motorist.

We hear that "a company known as The Automobile Emergency



AN AFRICAN BREAKDOWN.

Service Co. has been organised in southern California to give emergency service to automobile users. They have a scheme of installing jacks along the lines of the southern division of the Pacific Telephone and Telegraph Co., and furnish telephone service in cases of emergency to automobile owners. Every owner who is a client of the Automobile Emergency Co. will be supplied with a portable telephone, and will be advised of the points at which jacks have been installed along the various routes, so that in case of emergency he

Digitized by Google

can plug into the jack and call up any point in the southern division of the Telephone Co.'s territory.

"The Automobile Emergency Service Co. will own the jacks and the portable telephone sets, and the Pacific Telephone and Telegraph Co. will furnish telephone service, charging this service to the Emergency Co. If this scheme works out successfully it will doubtless be put in operation elsewhere."

Our *African* artist appears to have found inspiration in the theme.

MAJOR W. A. J. O'MEARA, C.M.G., R.E.

MAJOR O'MEARA, who has recently been appointed by the Postmaster-General to the position of Engineering Special Commissioner, was born at Calcutta on January 28th, 1863, and educated privately in India and England. In 1879 he began to read for the Indian Civil Service, but in the following year he decided to enter Woolwich. He was successful at the open competition for admission to the R.M. Academy, and he remained there for two years. In February, 1883, he was gazetted to the Royal Engineers, and, proceeding to Chatham, he attended the course of instruction at the School of Military Engineering, where he obtained the Fowke Medal. Early in 1885 Lieut. O'Meara went to India, and when the Burmese War broke out in 1885 he accompanied the Bengal Brigade of the Expeditionary Force to Burma, where he was employed on the lines of communication. In January, 1886, the young officer volunteered to take command of a party sent out from a post at Pagan to clear away some Dacoits from a village. This duty was accomplished successfully, and the Dacoits were driven off. In the skirmish, however, Lieut. O'Meara had emptied his revolver, and was in the act of reloading when a number of the enemy suddenly returned, and, surrounding him, inflicting in all eleven wounds with their dahs, breaking his jaw and permanently disabling his right hand. For his services he was mentioned in despatches; received the Frontier Medal with clasp; and, owing to the permanent character of his injuries, he was granted a wound pension. After being on the sick list for nineteen months, he was posted for duty at Portsmouth as Superintending Officer in connection with the reconstruction of the fortification and coast defences. In May, 1889, he was transferred to the "K" Telegraph Company, Royal Engineers, for employment under the

Digitized by Google

Postmaster-General, and in 1890 he surveyed for and constructed the London–Paris telephone trunk line through Kent. For his share in the work, which had been carried out in the face of many difficulties, he received the thanks of the Postmaster-General (the Right Honourable Sir James Fergusson). He had now been

MAJOR W. A. J. O'MEARA, C.M.G., ENGINEERING SPECIAL COMMISSIONER.

promoted to a captaincy, and in July, 1894, proceeded to South Africa for foreign service. While at the Cape he competed successfully for a vacancy at the Staff College, Camberley, and he returned to this country in December, 1896. In the following month he joined the Staff College, where he gained the coveted letters "*p.s.c.*" at the end of the course. In June, 1899, he was ordered to South Africa for secret service. When the Boer War broke out in October,

Digitized by Google

1899, he was in Kimberley, and he became the Senior Officer on Colonel Kekewich's staff.

During the defence of Kimberley he undertook not only the duties of Chief Staff Officer, but also those relating to intelligence, telegraphs, press censorship, etc. For these services Captain O'Meara was mentioned in despatches. On the relief of Kimberley he was attached to the Cavalry Division, and proceeded to Paardeberg. He was at Army Headquarters during the last attacks on Cronje's laager, and witnessed the surrender of the Boers on Majuba Day, 1900. After seeing considerable service in Bloemfontein in the establishment there of the civil government, he was in due course promoted to his majority, and when Johannesburg was occupied in June, 1900, he was directed to proceed to that place to take over the control of the municipality. He administered the affairs of the town single-handed for eleven months, acting as Mayor, Town Council, and Town Clerk. (According to the 'Times History of the War in South Africa,' vol. vi, Major O'Meara conducted the work of the municipality "with conspicuous ability and success.") For this service Major O'Meara was highly complimented by Lord Milner in his despatch to the Colonial Office of May 8th, 1901, and in the same year Lord Milner appointed him Government Commissioner of Johannesburg and District, and *ex-officio* chairman of the first Town Council. In a glowing tribute in the report of that body, the following words occur: "The work of the Council owes much to the knowledge of local detail which in eleven months this officer had added to his experience as an engineer, to the far-seeing ideas foreshadowed in the report drawn up by him on the future administration of the town, and to the readiness with which he won the confidence of the Council itself. . . . Major O'Meara will always be remembered here as one who did eminent services in a time of stress and difficulty." In the same connection he was again mentioned in high terms in Lord Milner's despatches.

After two and a half years' continuous service in South Africa without leave, Major O'Meara returned to England. In April, 1902, he was on the point of returning to South Africa, when he was offered, and he accepted, the position of Assistant Engineer-in-Chief at the General Post Office. He thereupon resigned his position in the Transvaal, and took up the duties of Assistant Engineer-in-Chief on April 28th, 1902. Major O'Meara retired from the Army in April, 1903. For his services in South Africa he received the C.M.G. and a medal with five clasps. On the retirement of Sir John Gavey in March, 1907, he was promoted Engineer-in-Chief of the British Post Office.

Major O'Meara was appointed one of the British delegates at

Digitized by Google

the International Conference on Electrical Units and Standards held in London in 1908, and he was the principal British delegate and a vice-president at the First International Telegraph and Telephone Technical Conference held at Budapest in the same year. At the latter conference he read a paper on "The Main Underground Telegraph System of Great Britain." In September, 1909, Major O'Meara visited America in his official capacity for the purpose of studying developments of engineering practice in relation to telegraphs and telephones (including automatics). He also took the opportunity of investigating the organisation of the great telegraph and telephone companies in that country, and the methods adopted for the conveyance of postal matter by means of mechanical appliances. Following this visit, Major O'Meara not only drew great attention to American methods of organisation, but he took a deep interest in the development of the British telephone system and in the introduction of labour-saving devices for the expeditious and economical treatment of postal matter in this country. Readers of this JOURNAL will remember the very interesting and instructive contributions which he made to the JOURNAL (July and October, 1910) in connection with his trip to the North American Continent. In 1910, he took a prominent part at the Second International Conference of Telegraph and Telephone Engineers held in Paris, and in September of the following year he represented the British Government at the International Congress on Applied Electricity at Turin. At that Congress he read a paper on "The Various Systems of Multiple Telegraphy." Major O'Meara was an *ex-officio* President of the Institution of Post Office Engineers, he is a Vice-President of the Institution of Electrical Engineers, Vice-President of the British Science Guild, a member of the Institution of Civil Engineers, a member of the Council of the Physical Society of London, a member of the Royal United Service Institution, and an external member of the Board of Advisers in Electrical Engineering at the University of London. During his presidency of the Institution of Post Office Electrical Engineers Major O'Meara delivered many important addresses, and on April 4th, 1910 (following his visit to America), he read a paper on "Depreciation" before the Institution. In December of the same year he read a paper on "Submarine Cables for Long-Distance Telephone Circuits" before the Institution of Electrical Engineers.

In his capacity as Assistant Engineer-in-Chief and in that of Engineer-in-Chief, Major O'Meara was personally responsible for many important reforms of an administrative character. He planned and took a personal part in the compilation of the original issue of the Post Office Engineering Department's Regulations. In this connection it is interesting to note that "The Code of Instructions to

Digitized by Google

Surveyors and Independent Postmasters, 1911," includes all the chief characteristics of the present print of the Engineering Regulations. The Unit Maintenance Cost System and the recently launched Unit Construction Cost System were also introduced into the Engineering Department by him. The utility of the Unit Maintenance Cost System for dividing the costs relating to the telegraph and telephone systems respectively was recognised by the Telegraph and Telephone Accounts Committee of 1907, and, more important still, a very considerable amount of public money has been saved as a direct result of the application of the Unit Maintenance Cost principle to the systems for which the Engineering Department is responsible. In 1908 Major O'Meara reorganised the engineers' sections throughout the country with advantageous results. That reorganisation involved a great step towards perfection in the matter of the arrangement of engineers' sections. That such is the case is amply proved by the fact that when the surveyors and engineering districts were reorganised and brought into harmony on November 1st last, the engineers' sections, as arranged in 1908, were, with a few relatively insignificant exceptions, used as a basis of the reorganisation, which was one of the most important during recent years. Major O'Meara's efforts culminated in a revision of the engineering grades which has given great satisfaction to Post Office Engineers generally. That he has always endeavoured to obtain proper recognition of the status and value of the work of engineers, and to protect their interests in other ways, not only in the Post Office but in outside circles, is a fact which is very widely appreciated, and it is, indeed, gratifying that he succeeded in persuading the authorities to improve considerably the status of Post Office Engineers before severing his connection with the Engineering Department. While the departure of such a distinguished chief can only be greatly regretted, it is hoped that in his new sphere he will enjoy better health, and that his future will be a happy and successful one.

We reproduce hereunder the graceful valedictory communication which Major O'Meara issued to the staff in terminating his association with them as Engineer-in-Chief.

"To the Members of the Engineering Department.

"In bidding an official farewell to the officers of the Engineering Department, I recall that when I joined the Department ten years ago I was practically a stranger. In the interval which has since elapsed I have come into very close contact with the majority of you, and have derived much pleasure in being associated with you in the increasingly important work of the Engineering Department of the Post Office.

Digitized by Google

"I desire to express my sincere wishes for the future success of your work, and my hope that reward commensurate with the responsibilities undertaken and the results achieved will be granted.

"In conclusion, I wish to place on record my high appreciation of the excellent response made by the staff to the heavy demands made on them, and my gratitude to all officers who have loyally supported me throughout my term of office as Engineer-in-Chief.

"W. A. J. O'MEARA.

"*February 29th*, 1912."

C. C. VYLE.

ON October 31st last Mr. C. C. Vyle left the Engineering Department of the Post Office to enjoy the rest that an energetic and well-spent life deserves. I say "rest," but there will be no sitting down in an armchair allowing the time to drag wearily on. The time will be used to enjoy to a greater degree those pleasures which a man in the engineering department has to curtail or forego during his official life, and which, when a man nears his pension time, if he has been wise enough to provide a second string to his life's principal work, calls him off from the involuntary to the voluntary and makes welcome the retirement, all save the "Good-byes."

"C. C. V." has wisely provided a passage from what is known as "active life" to retirement which is not revolutionary, but which is a glide from a happy official life to a healthier and more enjoyable private life.

"Vyle," for we all affectionately call him "Vyle," did not treat men as units although he did his best to be impartial. He treated them as human beings with souls, and as a consequence men would do for him, at inconvenience to themselves, what they would find too much trouble to do for themselves. He had the respect and admiration of all men—from the top to the bottom, both technical and clerical—and he deserved them both. Even those opposed to him on any point—and any technical man worthy of the name must have technical opponents; that follows from individuality—admit they never received uncourteous or unfair treatment.

Few men in the Post Office have made such strides in their work as he did in his, or made such impressions on the progress of telegraphy as he did. Every quadruplex circuit working to-day is working better because of Vyle's non-polarised relay. Every Wheatstone ABC circuit uses the combined indicator and bell of his, and all the longest and difficult circuits work on his condenser leak

Digitized by Google

system. The struggles round the question of the "decrement" versus "increment" working are still vivid in his memory, and his relish for sport found ample scope in this battle. Although decrement quadruplex working was not made universal, it is significant that the special racing staff, among whom he worked for thirty-two years, successfully appealed for its retention for their work. The inception of the polarised sounder was a move of far-reaching importance, and strange though it may now seem, he had given the idea to the Department twenty years previously. This instrument was the practical application of the fact that a small permanent magnet placed under the cores of an ordinary sounder reduced the current required to work it from 30 to 10 m.a.

Attached to Mr. Vyle officially in 1906 to develop the polarised sounder, he and I formed a friendship that nothing could break and a psychological combination that is inexplicable with our present

MR. C. C. VYLE, STAFF ENGINEER,
CONTROLLING EXPERIMENT ROOM.

knowledge. Often we turned up in the morning beaming with an idea that each had discovered independently during the night, and we often answered each other's questions before they were physically expressed—much to our astonishment at first. He possessed a practical and historical knowledge of telegraphy which, accompanied by a nature given to experimenting and the opportunity for doing so, proved invaluable to the success of our efforts.

Mr. Vyle's work as engineer, technical adviser on the racing staff and as staff engineer in charge of the Experimenting Room brought him into contact with many people, but nowhere, from all those with whom he has been acquainted, can one find a discordant note in the volume of well-wishing that goes out to him on his leaving the service of the Department. This must indeed be gratifying to him, for realising his duty towards his brother man he has lived to keep the peace and work in harmony with his colleagues, not to rise to power crushing and trampling under foot all who might prove obstacles in his path.

E. V. S.

Digitized by Google

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Office.	Name.	Appointment.	Previous Service.
Engr.-in-Chf.'s Office	Slingo, W. .	Engr.-in Chief	C. T. O., '70; Asst. Super., '90; 1st Cl. Tech. Officer, Eng'g Dept., '98; Suptg. Eng., '03; Asst. Engr.-in-Chief, '11.
„	Noble, W. .	Asst. Engr.-in-Chf.	Tel. Aberdeen, '77; Engr., 2nd Cl. '93; 1st Cl., '97; Tech. Officer, 2nd Cl., '00; Asst. Suptg. Engr., '01; Staff Engr., 1st Cl., '05; Suptg. Engr., '07.
„	Stretche, T. E. P.	Supertg. Engr.	Tel. Gloucester, '81; Jr. Clk., Eng'g Dept., '87; Draughtsman and Shorthand Writer, '92; Engr., 2nd Cl., '93; 1st Cl., '00; Tech. Officer, 2nd Cl., '03; Asst. Suptg. Engr., '07.
„	Johnson, T. B. .	„	S. C. Hull, '85; Jr. Clk, Eng'g Dept., '90; Engr., 2nd Cl., '94; 1st Cl., '00; Tech. Officer, 2nd Cl., '03; Asst. Suptg. Engr., '07.
„	Paterson, W. .	1st Engr., "Monarch"	2nd Engr., "Monarch," '93.
„	Allan, R. . .	2nd Engr., "Monarch"	2nd Engr., "Alert," '05.
„	Duncan, R. .	2nd Engr, "Alert"	4th Engr., "Monarch," '06; 3rd Engr., "Monarch," '11.
Supt. Engr.'s Office	Cornwell, C. W.	Clk., 2nd Class	Tel., C. T. O., '91; Jr. Clk., Eng'g Dept., '00.
„	Cousins, E. W. .	„	Tel., C. T. O., '84; Jr. Clk, Eng'g Dept., '00
„	Harry, M. . .	„	Tel., C. T. O., ,88; Jr. Clk., Eng'g Dept., '00.
„	Mullens, E. E. .	„	Tel., C. T. O., '89; Jr. Clk., Eng'g Dept., '00.
„	Williams, D. .	„	S. B. D., '95; Stores Dept., '97 2nd Cl. Engr., '98; Jr. Clk., Eng'g Dept., '03.
„	Harrop, F. N. .	„	S. C. & T., Manchester, '88; Jr. Clk., Eng'g Dept., '99.
„	Walker, A. T. .	„	S. C. & T., Manchester, '90; Jr. Clk., Eng'g Dept., '99.
„	Denton, J. C. .	„	S. C. & T., Nottingham, '91; Jr. Clk., Eng'g Dept., '99.
„	Graham, J. W. .	„	S. C. & T., Newcastle, '91; Jr. Clk., Eng'g Dept., '99.
„	Fletcher, G. E. .	„	S. C. & T., Derby, '92; Jr. Clk., Eng'g Dept., '99.
„	Milford, P. E. .	„	S. C. & T., Cardiff, '93; Jr. Clk., Eng'g Dept., '99.
„	Davies, E. R. .	„	S. C. & T., Chester, '93; Jr. Clk., Eng'g Dept., '99.
„	Johnston, R. R. .	„	S. C. & T., Newcastle, '90; Jr. Clk., Eng'g Dept., '00.

Digitized by Google

PROMOTIONS—(*cont.*)

Office.	Name.	Appointment.	Previous Service.
Supt. Engr.'s Office	Atkinson, F. W.	Clk., 2nd Class	S. C. & T., Leeds, '91; Jr. Clk. Eng'g Dept., '00.
,,	Johnston, T.	,,	S. C. & T., Newcastle, '92; Jr. Clk., Eng'g Dept., '00.
,,	Shadforth, F. J.	,,	S. C. & T., Newcastle, '94; Jr. Clk., Eng'g Dept., '00.
,,	Tyson, J.	,,	S. C. & T., Manchester, '91; Jr. Clk., Eng'g Dept., '00.
,,	Simms, J. T.	,,	2nd Cl. Tel., Belfast, '85; S. C. & T., Belfast, '94; Jr. Clk., Eng'g Dept., '00.

COMMUNICATIONS.

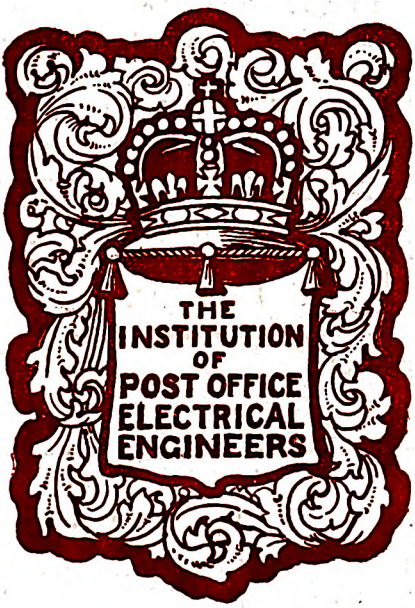
All Remittances and Agents' Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

Editorial Communications and Correspondence should be addressed to Mr. D. H. KENNEDY, Norbiggin, 26, Oakley Avenue, Ealing, W. (Telephone, 1000 Ealing.)

Digitized by Google

AUTOMATIC TELEPHONY.

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



VOL. 5
PART 2

JULY
1912

ADVERTISEMENT INDEX

Special
Double Number

Price 2/- net
Postage 4d. extra

Google

ESTABLISHED 1879.

THE

LONDON ELECTRIC WIRE COMPANY AND SMITHS, LTD.

Telegrams: "Electric, London." Telephone: No. 3105 London Wall.

Playhouse Yard, Golden Lane, London, E.C.

MANUFACTURERS OF

Every Description of Cables & Wires for Electrical Purposes.

Cotton-Covered & Braided Wires, Strips & Cables.
Silk-Covered Wires for Electrical Instruments.
Enamel Insulated Wires.
Multiple Cables for Telephones, &c.
Flexible Cords of all descriptions for Incandescent Lamps, &c.
Dynamo Brushes.
"Platinoid," "Eureka," AND OTHER High Resistance Wires.

Antwerp Telephone & Electrical Works,
ANTWERP.

Manufacturers of

TELEPHONIC APPARATUS

OF EVERY DESCRIPTION.

Wall Sets
Table Sets
Switchboards
Standard and Multiple
Domestic Sets

Bells
Receivers
Transmitters
All Accessories

Sole Agents for the United Kingdom—

W. F. DENNIS & CO.,

49, QUEEN VICTORIA STREET,
Stores: MILLWALL DOCKS, E. LONDON.
Telegrams: "FREDENNIS, LONDON." Telephone: BANK 343.

Digitized by Google

Digitized by Google

Digitized by Google

THE
Post Office Electrical Engineers' Journal

THE STROWGER AUTOMATIC EXCHANGE AT EPSOM.

By W. J. Bailey, A.M.I.E.E.

Automatic switching equipments of the Strowger two-wire type have been installed for the Department at Epsom and at the Official Switch, General Post Office, London, both replacing existing manual common battery signalling systems.

The contracts were placed with the British Insulated & Helsby Cables, Ltd., whose telephone works have recently been acquired by the Automatic Telephone Manufacturing Co., Ltd.

In this article it is proposed to deal principally with the Epsom equipment, as it has a greater number of special features than is provided for the Official Switch, viz. meters, coin box stations, electrophone subscribers, trunk (long-distance) circuits, etc. In the case of Epsom the mechanism will be on trial by the public and in the other case by Post Office officials of all grades at head-quarters.

No doubt there will be a spirit of rivalry between the two classes of users to win the favour of the "mechanical girl."

Even as politeness, patience, and compliance with instructions smooth the working of the manual system, and encourage the operator to rise to the occasion during the busy hour and yet not be lax during the slack period, so a fair treatment of the calling device placed at the disposal of the subscriber, patience in operating the dial, no foolish experimenting to determine how fast or how slow it is possible to operate the mechanism to the breaking-down point, with never-failing care to replace the receiver, will tend to produce

Digitized by Google

the best results and be the essence of the lubricating oil to smooth the working of the mechanical operator.

To give advice to those about to operate, we must add the following instruction to the famous negative of Punch—Don't—hustle or slow down the dial of the calling device.

As regards the choice of Epsom for the first public experiment, the following facts are in its favour: Its relatively high percentage of local traffic—actually it had the highest of any of the original London Post Office exchanges—the nature of its climatic conditions, the character of its telephoning public, its proximity to headquarters, and the special nature of some of its arrangements are such as will afford a good opportunity for testing the working of one of the several systems of automatic switching equipments which has attained success as a practical working system.

Epsom forms part of the outer London area, and has direct communication by means of junction lines with the manual exchanges at the London Central Exchange, Croydon and Sutton, and also a trunk or "long distance" line connection with Leatherhead.

The local subscribers are on the message rate system. One penny is charged for each originated local call, twopence for each originated junction call for London Central, Croydon, and other exchanges in the London area, and various rates for long-distance or trunk calls.

In these circumstances it is not possible to dispense entirely with operators. So far as is known it is not possible to provide meters which will differentiate between calls on such a varied tariff; therefore, a manual switchboard and a small operating staff are still required for attending to such classes of service as originated trunk call records, coin box stations, electrophone service, etc.

All incoming traffic from the manual exchanges will be intercepted at this manual switchboard. This avoids the necessity for equipping a special position at each of the manual exchanges (Croydon excepted) with a calling device and a transfer multiple between it and the other positions.

A position at the Croydon Exchange will be fitted with a calling device for use at night time, when all outside communication with Epsom will be concentrated at Croydon.

Each subscriber's line is equipped with a meter which registers only originated successful calls to other subscribers on the automatic system. The meters will not register any calls incoming to a subscriber, nor any call made for trunk service, information, complaint, nor for connection to subscribers on the manual exchanges.

Originated calls for trunk service will be ticketed by the Epsom operator.

The exchange operators at London, Croydon, and Sutton will

Digitized by Google

ticket all effective calls coming direct from the automatic subscribers over the junction circuits.

The insertion of coins for calls to and from public coin box stations will be supervised by the Epsom operator, who will also have facilities for offering Trunk calls to engaged subscribers.

Some authorities are of opinion that an automatic exchange of about 500 lines is a size where that system begins to show an economy. It is necessary, therefore, in considering the experiment from an economic point of view that the special nature of some of the requirements should be taken into account.

A record of the cost of maintenance will be kept and compared with a manual exchange of similar size, and the results will be awaited with interest.

A lay-out plan showing the location of the various parts of the equipment is given in 1.

The present exchange building, originally an ordinary dwelling house, has had to be strengthened to carry the increased weight of the new equipment. The arrangement of the apparatus may, therefore, not be above criticism, and yet may not unreasonably be considered the best possible in the circumstances.

The power plant occupies two rooms in the basement.

The automatic switching equipment is installed on the ground floor, and consists of—

Five line switchboard units, each having 100 line switches, 100 meters, 10 ordinary connectors, 1 test connector, 1 trunk offering connector and 2 master switches.

Eighty first selectors, 40 second selectors.

One special connector for coin box station and 4 figure numbers.

The ultimate size of the system is arranged for 1500 numbers.

The auxiliary items on the same floor are as follows: 1 Testing bench, 1 Test desk, 1 Main Frame, and 1 I.D.F.

The Information and Trunk Switchboard is installed on the first floor.

In this article it is proposed to divide the description of the switching equipment into three parts:

(1) A general description of the switching scheme.

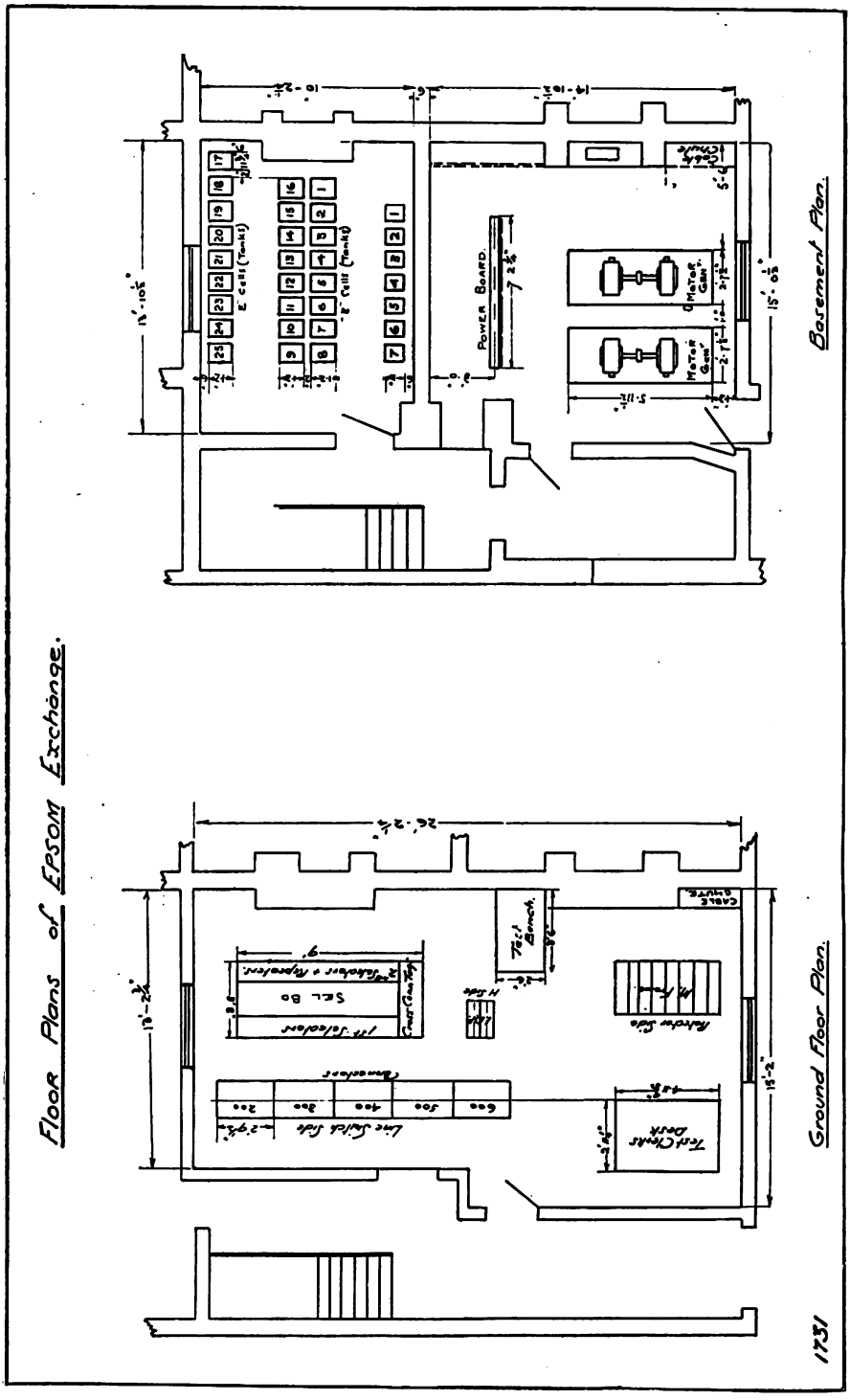
(2) Consideration of technical details and circuit diagrams of the automatic switching equipment.

(3) Consideration of the auxiliary items, such as the Manual Switchboard, Test Bench, Test Desk, Power Plant and circuit diagrams connected therewith.

PART I.

As the first principles of the Strowger system have not been discussed in this JOURNAL, it is considered advisable to preface this

Digitized by Google



I.—Lay Out.

Digitized by Google

description by a brief explanation of the principles involved, for the benefit of those readers who have not had the advantage of previous information.

First, take the case of 100 subscribers, with numbers 00 to 99. This exchange system would be called a two-figure system. The lines are connected to 10 rows of 10 switchsprings, or bank contacts, in their proper order as indicated at C on the plan of the switching scheme, 3, which will be considered in detail later.

In connection with this bank of contacts and placed above it is a second bank called the private bank not shown in the plate. There is also a shaft having two sets of wipers jointly performing the same function as a three-way manual plug, but making contact by sliding movements instead of by insertion. This shaft, by means of a suitable combination of electro-magnets, relays, ratchets, pawls and detents can, by a series of electrical impulses, be stepped up on the left-hand side of the bank to the level of any particular tens row, and then by a second series of impulses wipered or slid over the intervening contacts in a right-hand direction until the wipers reach the particular contacts required.

This combination is called a "CONNECTOR" and is illustrated in 8, 9, and 10.

It is possible to connect the two lines of a telephone to the wipers and controlling electrical apparatus so that the subscriber, by means of a calling device which controls the number of impulses, can cause the wipers to be lifted and then rotated so as to connect his line to any number he may wish. In its simplest form this calling device is a make-and-break key.

The bank contacts of these connectors are multipled together. When a line is engaged the private bank contact associated with it is earthed, and matters are so arranged that while travelling and until the private wiper has tested the private bank contact, the line wipers are disconnected in order to prevent interference with other circuits. If the private wiper finds an earth when it stops travelling a busy tone is given to the calling line.

When more than 100 lines are in use, two or more groups of connectors are required, together with a means of selecting the particular 100 group. The subscribers' lines must, therefore, be connected to a "SELECTOR" instead of to a connector. These two items are similar in many respects, as will be seen by referring to 10 and 13. The differences will be discussed later. The first series of impulses from a calling device will now select the particular 100 group, and the selector wipers will be lifted to the particular 100 row and then automatically swept along the contacts to find an idle connector line. The second and third series of impulses will operate a connector in that group to which the required line is con-

Digitized by Google

nected. Such an exchange system would be called a three-figure system, as three series of impulses are necessary to obtain connection with a subscriber.

As the scheme developed it was found possible by the introduction of line switches to avoid giving each subscriber the sole use of an expensive selector or connector.

We can now consider the actual "SWITCHING SCHEME" as drawn up for Epsom and shown in 3.

A LINE SWITCH—shown diagrammatically in 17—consists of a four-coil relay with three armatures, one of which, when operated, causes the plunger to enter one of ten sets of springs which are placed together in a horizontal row as shown at L. Each subscriber's line has one line switch and one row of contacts allotted to its own particular use. To this row the subscribers' line is multipled. Separate selector lines are also connected to each set of contacts. The ten selector lines are multipled vertically to each of the 100 banks in the unit as shown at L, providing a 10 per cent. trunking scheme for outgoing traffic. This percentage can be increased, as will be shown later.

When the line switch is operated by the subscriber lifting the receiver, the plunger enters an idle set of contacts and joins his line to a first selector. Immediately this takes place the remaining plungers belonging to the other subscribers' lines are shifted by the master switch shaft and directed towards the next idle selector line. This action is described more fully later.

The subscribers' lines from the main frame are brought to their individual line switches, and from there are multipled to the twelve connector banks of their own hundred group which are fitted on the reverse side of the switch unit framework. For the sake of clearness the connectors and line switches are shown at opposite ends of the switching scheme plan, and for the same reason no private banks or wipers are included, and only one bank of each group of selectors and connectors are shown.

It should be noted that the subscribers' circuit at the connectors is only multipled to the twelve connector banks of its own particular group. The reason for this is, of course, that groups must be kept separate.

The system of numbering is as follows:

Subscribers' Nos.	200–799
London Central Exchange	15
Croydon Exchange	16
Sutton Exchange	17
Information and complaint circuits to Manual Switchboard	8
Test desk	9

Digitized by Google

Long distance calls 0
Coin box stations (special four-figure circuits) . 1910–1929

The single-figure circuits such as 8, 9 and 0 are direct trunk lines from their respective levels of the first selectors to the manual switchboard and test desk. The two-figure circuits 15, 16, 17 and 18 are trunk lines between the first and second selectors. The four-figure circuits 1911, etc., terminate on a special connector reached *viâ* the second selector, and are not in use at present.

From each of the 10 levels of the first selectors there are 10 outgoing "transfer" circuits as follows:

1st level	. 10	circuits to 10 2nd selectors.	
2nd „	. 10	„ to 10 connectors .	200–299 subscribers' groups.
3rd „	. 10	„ to 10 „ .	300–399 „ „
4th „	. 10	„ to 10 „ .	400–499 „ „
5th „	. 10	„ to 10 „ .	500–599 „ „
6th „	. 10	„ to 10 „ .	600–699 „ „
7th „	. 10	„ spare for additional subscribers.	
8th „	. 10	„ to manual switchboard for information and complaints.	
9th „	. 10	„ to test desk.	
10th level or 0 level	10	recording circuits to manual switchboard for originating trunk calls.	

A connector bank is numbered as in **2.**

01	02	03	04	05	06	07	08	09	00
91	92	93	94	95	96	97	98	99	90
81	82	83	84	85	86	87	88	89	80
71	72	73	74	75	76	77	78	79	70
61	62	63	64	65	66	67	68	69	60
51	52	53	54	55	56	57	58	59	50
41	42	43	44	45	46	47	48	49	40
31	32	33	34	35	36	37	38	39	30
21	22	23	24	25	26	27	28	29	20
11	12	13	14	15	16	17	18	19	10

2.—METHOD OF NUMBERING CONNECTOR BANK.

The reason for this peculiar numbering will doubtless be readily understood. When the subscriber's dial is operated from the figure 0, ten impulses are transmitted to the controlling apparatus; therefore in a connector bank all subscribers' lines having 0 for the tens digit must be connected to the top row, those having 1 as the units digit occupy the first contact of each row, whilst those whose numbers terminate in 0 occupy the last contact of each row.

In the selector banks the 0 level must also be at the top.

Digitized by Google

The line switches correspond to the subscribers' signalling apparatus at a manual exchange.

The connector banks correspond to the subscribers' multiple from which the called subscriber is reached.

The scheme for effecting a connection between two subscribers is, generally speaking, as follows:—

Say subscriber No. 252 desires to ring up No. 460.

First, on lifting his receiver his line switch plunger connects him to a disengaged first selector.

Second, the calling device, which is described later (see 14 and 16), is pulled round from figure 4 and let go. The first selector wipers are lifted to the level of the fourth row to which 10 connector circuits to the 400 group are connected. The wipers are then rotated automatically until a disengaged connector line is found.

Third, the calling device is operated from figure 6. The connector wipers are lifted to the level of the sixth row on the 400 group.

Fourth, figure 0 is pulled round and the connector wipers are moved along the row until the tenth bank contact is reached. Ringing current is then applied if the circuit is not engaged, until the called subscriber answers.

To originate a trunk call the subscriber lifts his receiver and pulls round his dial from the 0 digit. The first selector wipers are then lifted to the 10th level and automatically move along this row until a disengaged circuit is found. A lamp glows at the manual switchboard, the operator replies and takes particulars of the call.

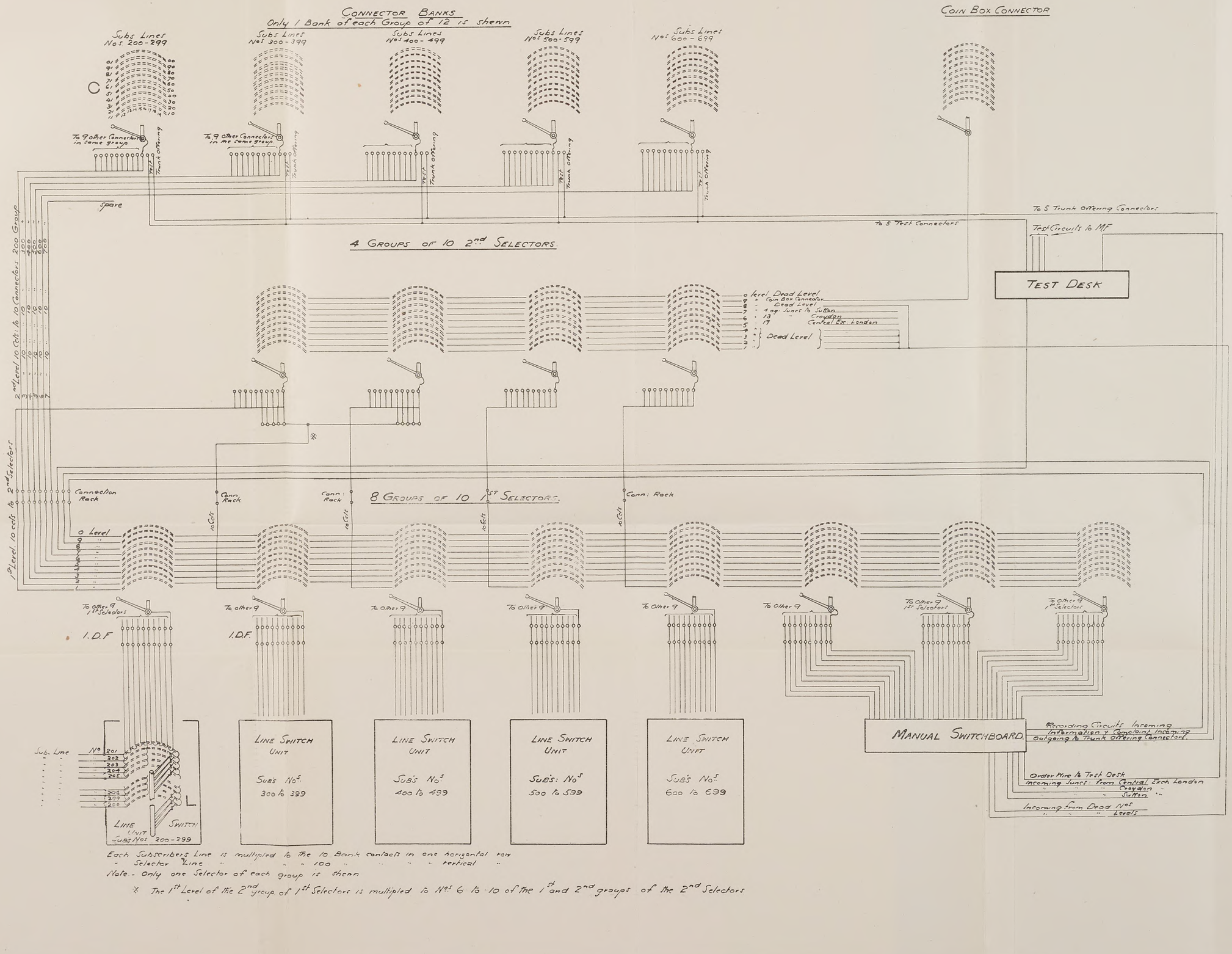
To obtain connection with a subscriber on a manual system, say at the Central Exchange, London, the calling subscriber after lifting his receiver pulls round his dial from figure 1. The first selector wipers are lifted to the first level, and rotate until a disengaged circuit to a second selector is found.

The dial is next pulled round from figure 5 by the subscriber. The second selector wipers are lifted to the fifth level and then rotate automatically until a disengaged outgoing junction line to the Central Exchange, London, is found. The manual exchange operator replies, ascertains the number of the subscriber required, and then switches the circuit through in the usual way and records the particulars on a ticket.

Attention is drawn to the second selector groups and their allocation to the first selector and line switch groups. The arrangement shown gives the sole use of ten second selectors to the 500–599 group which has the highest percentage of outgoing junction traffic. The 600–699 group shares ten second selectors with the manual switchboard. The 200–299 and 400–499 groups have each five second selectors appropriated for their use and five others in common with the 300–399 group.

Digitized by Google

AUTOMATIC TELEPHONE EXCHANGE.
EPSOM SWITCHING SCHEME.


Connector Banks
Only 1 Bank of each Group of 12 is shewn
Subs Lines Nos 200-299
Subs Lines Nos 300-399
Subs Lines Nos 400-499
Subs Lines Nos 500-599
Subs Lines Nos 600-699
Coin Box Connector
To 9 other Connectors in same group
Trunk offering
To 5 Trunk offering Connectors
To 5 Test Connectors
Test Circuits to MF
TEST DESK
4 Groups of 10 2nd Selectors
2nd Level 10 Cct. to 10 Connectors 200 Group
0 level Dead Level
9 " Coin Box Connector
8 " Dead Level
7 " Jct to Sutton
6 " 13 " Croydon
5 " 17 " Central Ex. London
4 } Dead Level
3 }
2 }
1 }
8 Groups of 10 1st Selectors
Connection Rack
Conn: Rack
To other 9 1st Selectors
I.D.F.
Sub. Line
No 201
202
203
204
205
206
207
208
209
200
Line Switch Unit Subs Nos 200-299
Line Switch Unit Subs Nos 300 to 399
Line Switch Unit Subs Nos 400 to 499
Line Switch Unit Subs Nos 500 to 599
Line Switch Unit Subs Nos 600 to 699
MANUAL SWITCHBOARD.
Ringing Circuits Incoming
Information & Enquiry Incoming
Outgoing to Trunk Offering Connectors.
Order Wire to Test Desk
Incoming Junct: from Central Exch London
" " " Croydon
" " " Sutton
Incoming from Dead Nos Levels
Each Subscribers Line is multipled to the 10 Bank contacts in one horizontal row
" Selector Line " " " 100 " " " " vertical "
Note - Only one Selector of each group is shewn
* The 1st Level of the 2nd group of 1st Selectors is multipled to Nos 6 to 10 of the 1st and 2nd groups of the 2nd Selectors

1831

Digitized by Google

A

a

w

is

to

16
wi
ci
ro

ne

m
Ri
cal

ro
lift
a
sw

at
his
wi
cir

Th
rot
Ce
op
an
the

tio
sho
wh
600

board. The 20)–499 groups have each five second selectors approp use and five others in common with the 300–399 gro

Digitized by Google

The junction groups which exceed ten, such as the Croydon and London Central Exchange junctions, will be divided between the groups according to the traffic conditions. A certain number of junctions will be common to two second selector groups, while others will be connected to one second selector group only.

It is the general practice to reserve the tenth level on the first selector for giving subscribers direct connection to the operator for originating a trunk or long-distance call. Hence, in a three-figure exchange the numerals 000 to 099 are not used. Similarly in a four-figure exchange numbers 0000 to 0999 are not available. The 0 figure on the dial is usually marked "0 long distance," *i.e.* a trunk call.

By the introduction of a second selector in each of the ten circuits outgoing from the 0 level, it is obvious that numbers beginning with 0 could be used. The public, however, are somewhat chary of accepting a cipher for the first figure.

In common parlance "nought stands for nothing," and a subscriber on the automatic system if offered a number such as 002 might be afraid that his clients would not bother to signal the first two ciphers, considering that the signalling of two nothings was placing an unnecessary burden upon them.

Of course a letter could be substituted for the cipher to overcome the objection, but on the whole it is generally accepted that for long-distance calls one "long pull" of the dial from the 0 digit is the best arrangement.

Generally speaking a three-figure exchange requires only first selectors and connectors to provide for 900 subscribers, but where special services are required, such as information, trunk call records and outgoing junctions to other exchanges, second selectors are required and even then the three-figure subscribers' numbers may be further reduced.

The present provision for the information, complaint and test-desk service is somewhat prodigal, but as the first selector levels are not immediately required, two have been appropriated. By making the 0 level of the first selector with its ten direct circuits to the manual switchboard serve for the originated trunk call records, information and complaint and test desk services, there would be available eight levels for subscribers' connecting groups, thus providing for 800 subscribers' lines. If more are still required, 600 additional lines having four figures could be arranged for by using the first, second, third, fourth, eighth, and 0 levels of the second selectors. The numbers would thus range from 1000 to 1499 (= 500) and 1800 to 1899 (= 100). Adding to these the four-figure numbers in the special coin box connector group, viz. 1900 to 1999, we reach the total of 1500 numbers mentioned in the equipment particulars.

Digitized by Google

Before this plan is adopted, however, the question of its effect on the junction traffic to other exchanges will require consideration.

The question of combining in one exchange system three and four figures, or four and five figures, is an interesting problem, and presents opportunities for catering for the needs of certain areas, but it is a subject too large to be dealt with within the limits of this article.

RELEASE METHODS.—In the Strowger system there can be several methods of severing the connection on completion of the conversation. Two of these methods may be mentioned, viz.: (1) *The Standard American practice*, in which the circuits are so wired that the connection once made is only severed when the *calling* subscriber replaces his receiver; and (2) the *back release*, where the arrangements are such that the subscriber who first replaces his receiver clears the connection.

The objection urged against (1) is that the calling subscriber who controls the release can tie up the other party by leaving his receiver off the hook, whether intentionally or not. Unfortunately, the party suffering is not aware that he is tied up. His circuit is "guarded" against other calls, and subscribers desirous of a conversation with him receive the busy tone. It is not until he originates a call, and fails to obtain either the connection or the busy tone, that he is aware there is anything wrong. By a continued up-and-down movement of the receiver hook it is possible to attract the attention of the apparatus attendant, who, hearing the unrhythmic clicks of the relays, would break into the circuit to ascertain the trouble, sever the circuit, and apply the howler to attract attention to the displaced receiver. It is contended, however, that seldom or never is this brought about wilfully for the purpose of deliberately blocking a subscriber's line.

This objection may be overcome, however, in a very simple manner, by the introduction of a supervisory alarm signal which operates when the called subscriber has restored but the calling subscriber's receiver is still off the hook. By providing in addition to the alarm signal, a supervisory lamp for each 100-line unit, the switchboard attendant can at once locate the offender.

In the Manual system the home operator would notice that the clear signal had been received from one subscriber only, and would break into the circuit and clear.

The objection to the Back Release is that if a called subscriber depresses the receiver hook accidentally or replaces his receiver in order to fetch to the instrument a person who is wanted, he breaks down the circuit, and the calling subscriber has to make another call.

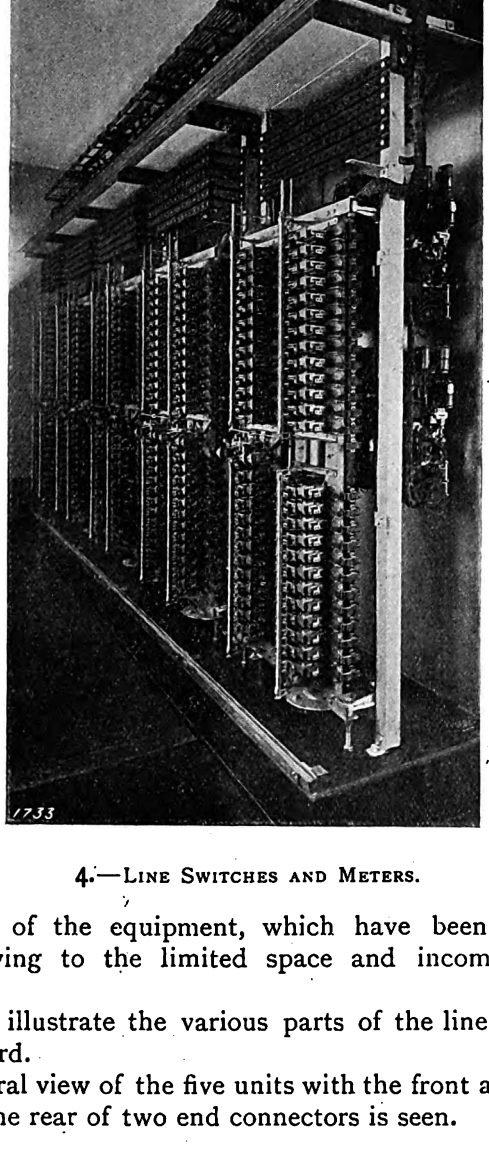
For the Epsom system it was decided to accept the standard practice, but that the circuits should be so wired that the system may be changed to "Back Release" without undue expense if required

Digitized by Google

later. As will be seen when considering the circuit arrangements, this will be a simple matter.

PART II.

At this stage it may be well to refer to the photographs of the



4.—Line Switches and Meters.

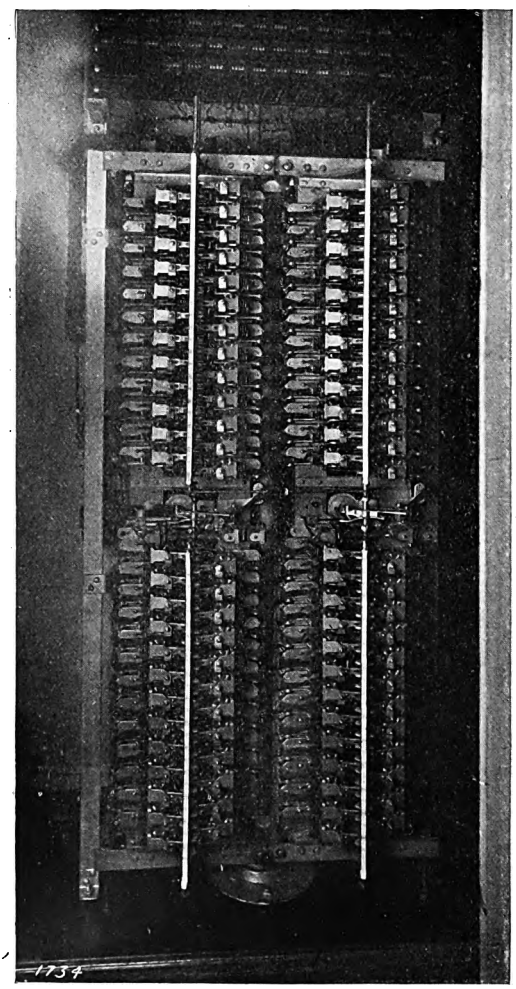
various parts of the equipment, which have been taken under difficulties owing to the limited space and incomplete state of installation.

4, 5, and 6 illustrate the various parts of the line switch side of the switchboard.

4 is a general view of the five units with the front and end covers removed. The rear of two end connectors is seen. The two sides

Digitized by Google

of the framework correspond with the home position and the multiple respectively on a manual system, the former being the line switch side, the latter the connector side. Above the roof is a cable run, and also a panel for the bus bars and fuses. The meters are fitted above the line switches of the first four units. The fifth unit was



5.—One Line Switchboard Unit with 100 Line Switches.

not completed when the photo was taken. The mounting plates are in position, but no meters are yet fitted on that unit. The right-hand master switch is also omitted.

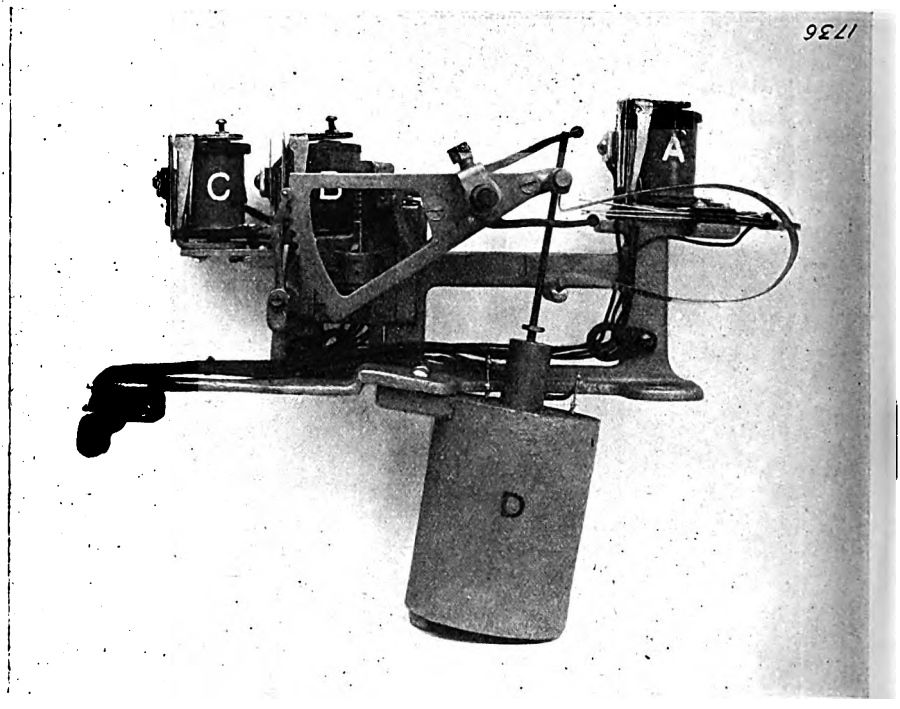
The full equipment of each unit consists of four groups of 25 line switches with a master switch in the centre of each vertical. The master wiper and banks which are in use are at the bottom of each

Digitized by Google

Digitized by Google

vertical. An extra master switch bank is fitted at the top of each vertical, where there is also space for an additional master switch. It is therefore possible to split each unit of 100 into four separate groups of 25 each, and to work them independently if desired. In ordinary circumstances only one master switch is in use, the moving shafts of the right-hand vertical being coupled to the left hand vertical of its own unit. The right-hand master switch is, therefore, always in reserve in case of breakdown.

5 shows one complete unit.



7.—Solenoid Master Switch. A. Trip Relay. B. Locking Magnet. C. Starting Relay. D. Solenoid.

6 the same unit, but with the two vertical frames swung open to show the wiring and framework.

The selector springs of each group of 25 line switches are cabled to separate tags at the top of the frame, where they are multipled together and then connected in pairs to two 40-wire cables which are run to the I.D.F. strips, where, however, only one of the cables is jumpered across to the first selectors attached to the group. The other cable is left spare.

By this arrangement the outgoing trunks to the first selectors may be increased to any desired number up to 20 without altera-

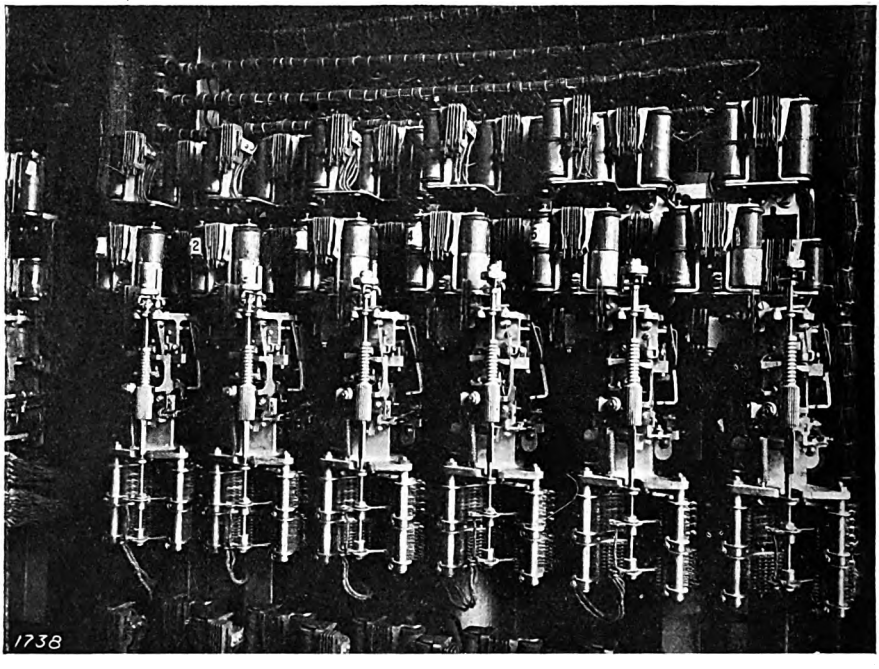
Digitized by Google

Digitized by Google

tions at the line switches. The teed connection between the two pairs of tags of the two verticals will require cutting, and the spare cable jumpered at the I.D.F. to a cable going to additional selectors.

The solenoid master switch is illustrated in 7. The notched quadrant is shown in position 1. The action of this apparatus is explained later.

The connector side of the switchboard is illustrated in 8. The iron sliding doors have been removed. Each unit has two rows of



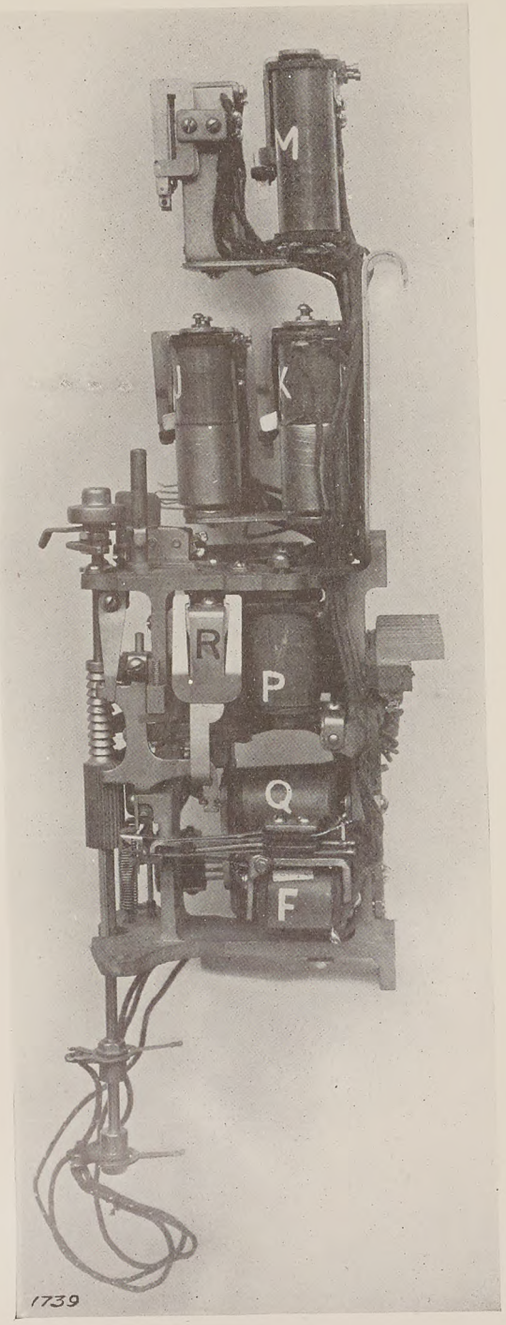
9.—One Row of Six Connectors.

six connectors. In each case the Offering Connector is located at the right-hand side of the upper row. The Test Connector is placed in a similar position in the lower row. Space is available for six additional connectors if required. This would increase the percentage of possible simultaneous incoming calls to 17 per cent.

The tell-tale relays, supervisory lamps and connecting tags are placed at the top of the framework.

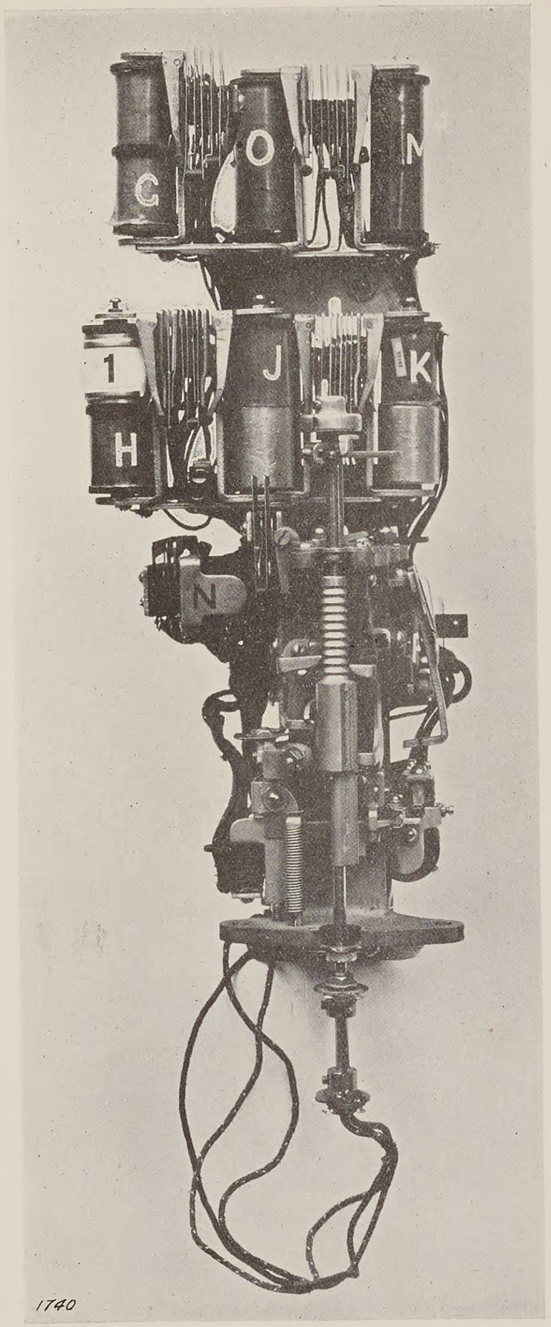
9 is a view of the six connectors on the upper row of the first unit. Only two groups of bank contacts are now provided with each connector. The wipers are here shown making contact with subscribers' lines whose numbers are 210, 220, 230, 240, 250 and 260 respectively.

Digitized by Google

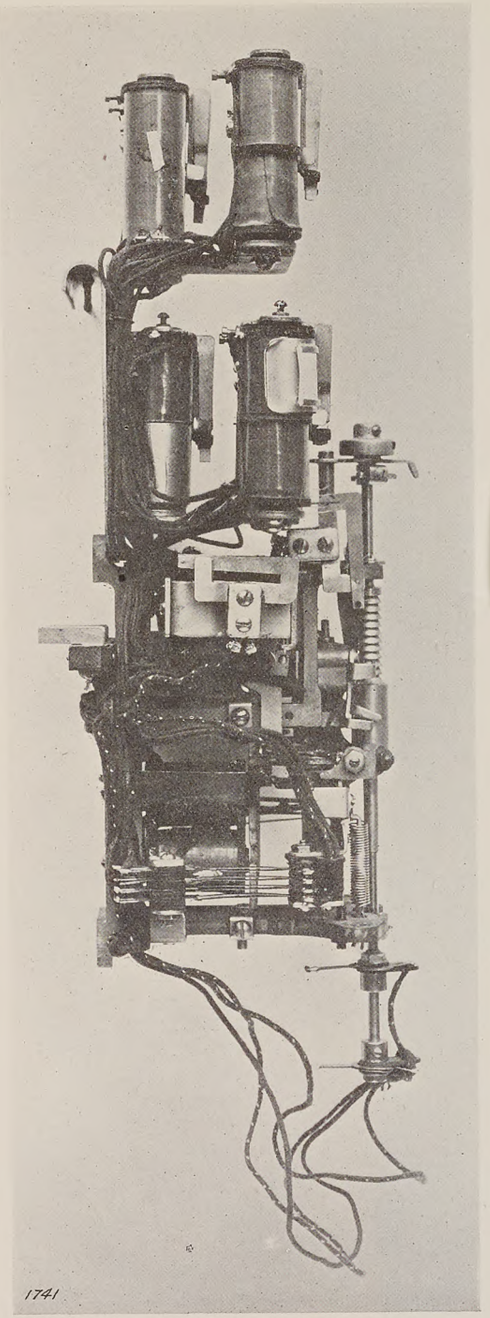


M Private Magnet.
K Backbridge Relay.
J Line Relay.
R Release Relay.
P Ring Cut Off Relay.
Q Busy Relay.
F Ring Relay.
N Back Release Relay.
H Vertical Magnet.
1 Rotary Magnet.
Release Magnet Armature.

10.—Connector. Right Hand Side View.



10a.—Connector. Front View.



10b.—Connector. Left Hand Side View.

Digitized by Google

A

ti
p
s
s

q
e

ir

si
th
in
ac
ag

pl

ur
ea
st
re

I

Digitized by Google

The details of the connector are brought out more clearly in the three views given in 10, 10 *a*, and 10 *b*.

The functions of the principal electro-magnets are as follows:

VERTICAL MAGNET.—Armature when operated steps up the shaft by means of a pawl engaging with the horizontal ratchet ridges, lifting the wipers to the required level in response to the tens digits signalled by the calling device.

THE ROTARY MAGNET.—Armature when operated engages with the vertical ratchet ridges and shifts the wipers along to the required bank contact in response to the units digits signalled by the calling device.

This rotary action is not possible until the shaft has been lifted one step up so as to release the off-normal contacts X and Y (see 17).

PRIVATE MAGNET.—Armature disconnects the line wiper leads during the time they are travelling over the intermediate bank contacts. Also by means of an extension with an escapement action allows the side switches to be shifted to their next position.

RELEASE MAGNET: Armature when operated breaks away the detents which hold the wiper shaft, so that it rotates back under the tension of the cap spring and then falls by gravity.

Relays J and K are slow acting; the inertia effect being produced by the thick copper sleeves which are slipped over half the core, the coil being wound over the other half.

11 is a view of the first selectors, which face the connector side of the line switchboard.

There are four shelves, each carrying 20 selectors per shelf. The second selectors are on the other side of this switchboard and cannot be seen.

12 is a view of the end of the selector switchboard, showing the supervisory lamps and relays, also giving an idea of the interior. The rear side of the second selector shelves is shown on the left. At the remote end is the connection rack.

Sliding doors fitted with glass panels are provided for this switchboard.

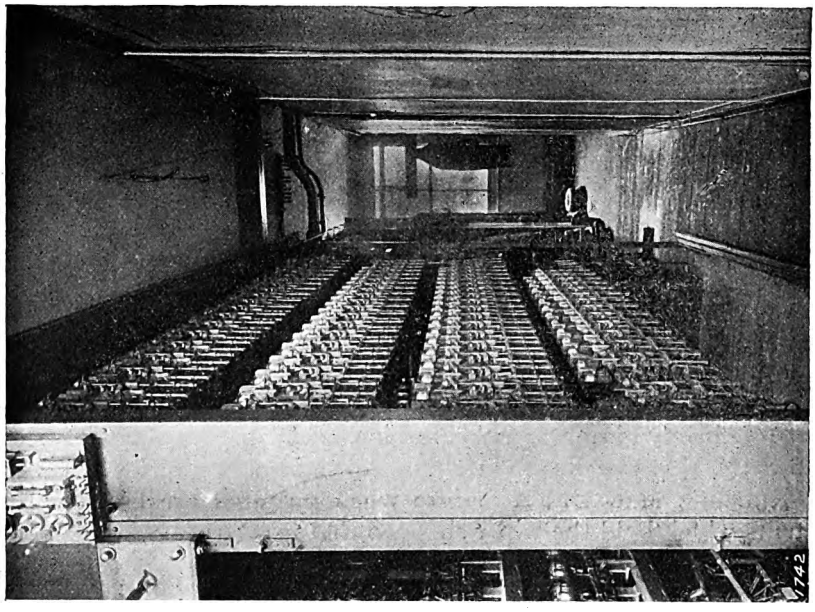
Detailed views of a selector are given in 13.

The selector differs from the connector mainly in the following respects: There are no side switches; the rotary movement is not under the control of the calling device. After the cessation of the impulses which lift the shaft, the rotary magnet by a make-and-break action rapidly shifts the wipers along the level until an idle line is found. If all lines are engaged, the rotary magnet armature vibrates rapidly with a buzzing sound until released.

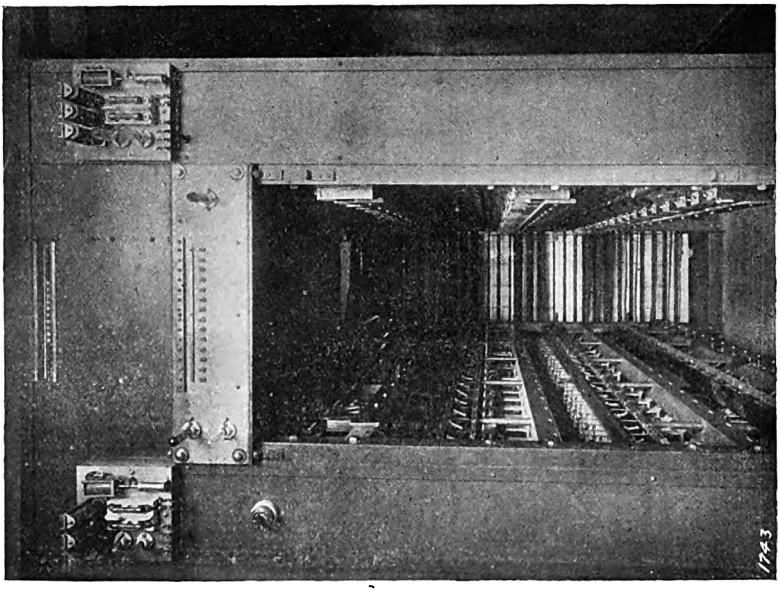
The selectors and connectors are readily removed or fixed. The back bracket hook of the connector is hung over the supporting rail

Digitized by Google

of the framework and the flat jack springs fitted into the permanently wired double spring contacts on the frame. The selector has a



11.—Selector Switchboard. First Selector Side.

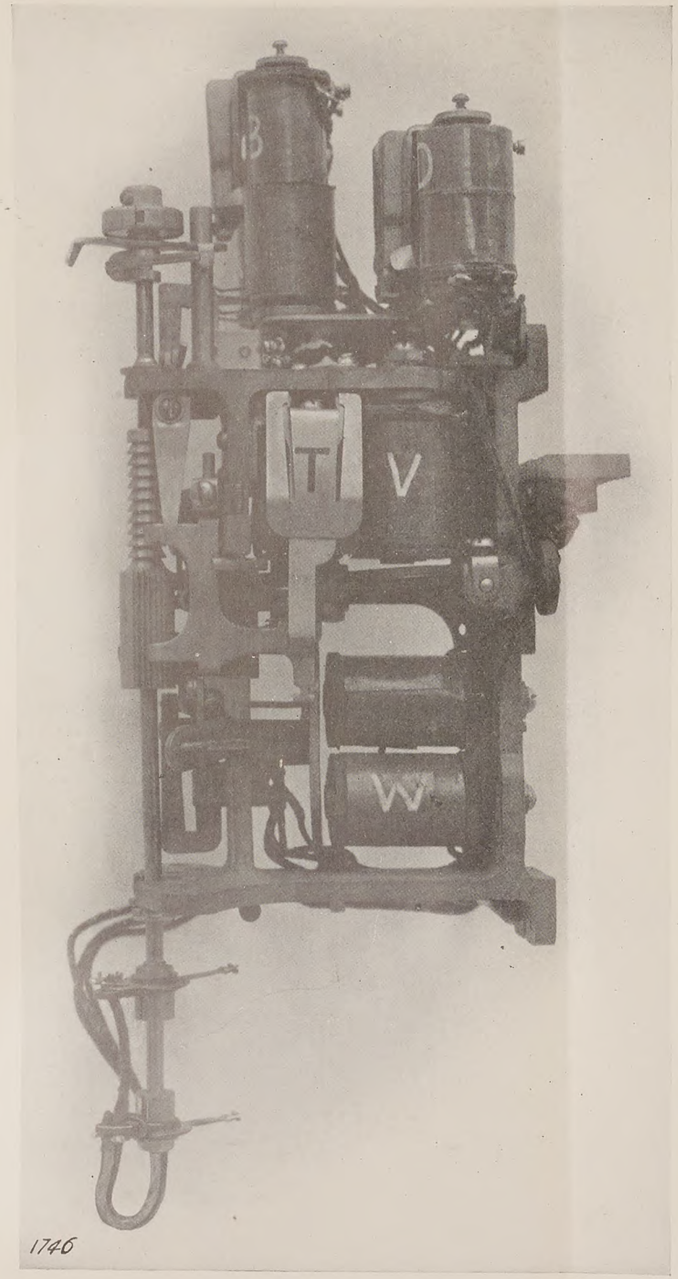


12.—Selector Switchboard. End View showing Alarm Relays and Lamps.

slotted bracket for fixing purposes. Space limitations prevent a more detailed description of the working parts.

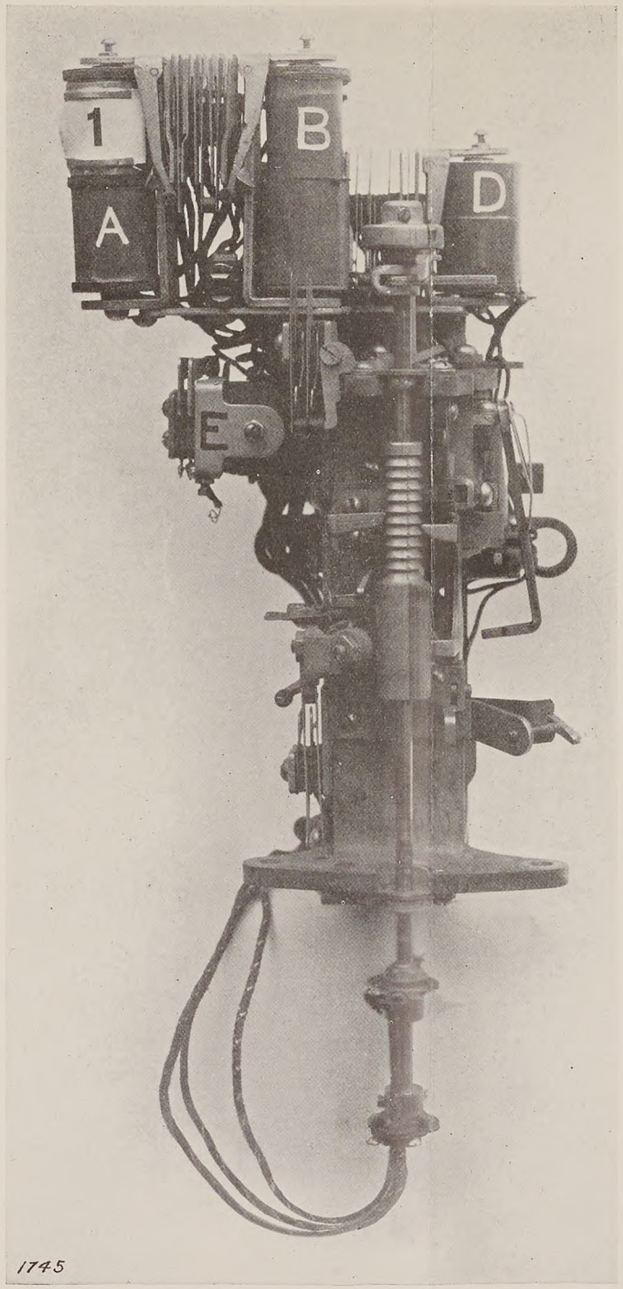
Digitized by Google

A. Line Relay.
B. Release Relay.
C. Line Switching Relay.
D. Series Relay.
E. Private Relay.
F. Release Armature.
T. Vertical Magnet.
V. Rotary Magnet.



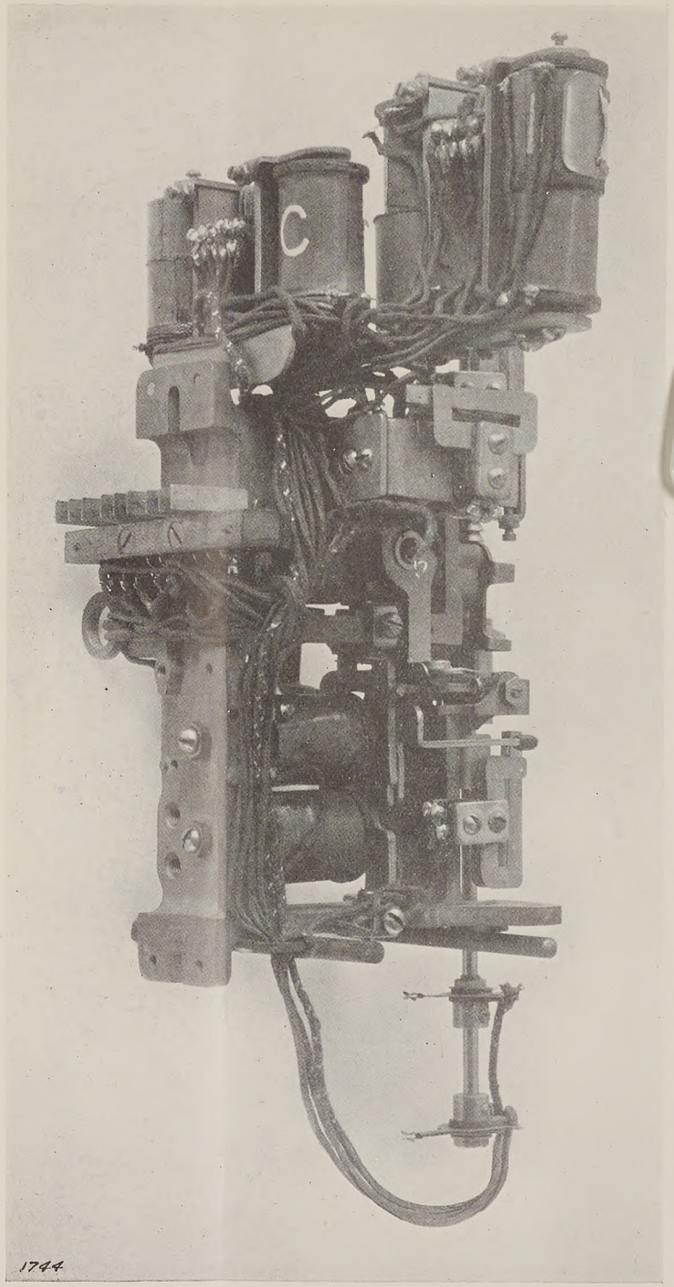
1746

13.— Side-Switchless Selector. Right Hand Side View.



1745

13a.—Side-Switchless Selector. Front View.



1744

13b.—Side-Switchless Selector. Rear and Left Hand Side View.

Digitized by Google

A

o
w

sl
m

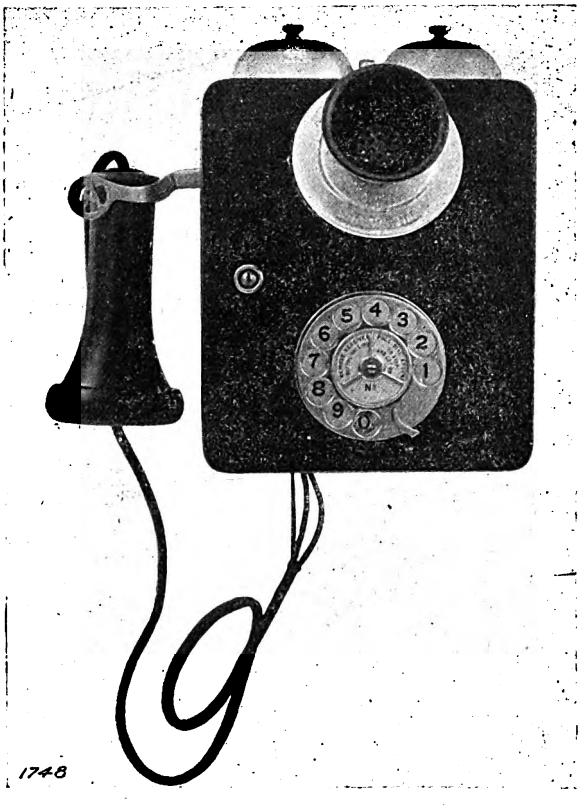
13

Digitized by Google

A consideration of the many mechanical details can well be reserved for a subsequent article as special drawings will be necessary.

CIRCUIT CONNECTIONS BETWEEN TWO AUTOMATIC SUBSCRIBERS.

17 shows the complete sets of apparatus required when two subscribers are in conversation.



14.—WALL SET.

Dealing first with the SUBSCRIBER'S TELEPHONE it will be noticed that it differs from that in general use on the manual C.B. system in two features, viz.

(1) A calling device is attached as shown in 14 and 16.
(2) The receiver is of the electro-magnet type.

CALLING DEVICE.

The function of the calling device is (*a*) to break the line circuit the required number of times at a given speed, and (*b*) to cut out the

Digitized by Google

receiver during the signalling operations. One finger is inserted in the hole above the number required and the dial pulled round in a clockwise direction until the finger reaches the stop. The finger is then withdrawn and the dial let go. This operation is repeated for each digit, a fresh number not being started until the dial is at rest. 15 is a plan view of the under side of the calling device showing the spring contacts and controlling mechanism.

Side views of the contact springs are also given. Normally, the interrupter springs J1 and J2 are in contact and the shunt spring S is held away from spring J2 by the stop pin, the arm of which is fixed to the extended axle of the finger-hole dial. Thus when the dial is pulled away from its normal position it tightens up the spiral spring, which provides the motive power for its return, and also rotates the stop pin, releasing the shunt spring S, which then makes contact with J2, shunting the receiver out of circuit until the return of the dial, preventing any annoying clicks therein, and providing a non-inductive loop across the line during signalling. When the dial is let go, the dial ratchet spring engages with a notch in the larger toothed wheel, which then rotates with the dial, and the rotary motion is transmitted by means of a pinion to the smaller toothed wheel and the interrupting cams. These are rotated, the toothed wheel engages the worm screw of the centrifugal speed governor which controls the speed of rotation, while the interrupting cams rotate in turn between the interruptor springs J1 and J2, thus momentarily breaking the line circuit as they pass. On the speed governor shaft are two bent springs having metal bobs which normally rest in the slots of the disc. When rapidly rotated the bobs fly outward and the speed is controlled by the friction of the bobs against the inner side of the protecting drum.

This latest type of calling device is more simple in construction than its predecessor, which had a locking arrangement to prevent subscribers pulling round the dial for the next digit before the previous figure had been fully signalled.

A warning is issued against pushing back the dial to assist its return motion, also against holding it back to retard its return. Subscribers are hardly likely to ignore this warning seeing that such an interference on their part is likely to cause a connection with a number other than the one they require and for which the meter may register against them. The finger holes also correspond with the number of figures, viz, 10, and not 11 as in the other type. The dial cannot be overwound; a stop plate prevents this. The calling device is easily removed; one screw only is sufficient to hold it safely in position.

Each calling device before being issued from the works of the Automatic Co. is adjusted to give ten interruptions per second,

Digitized by Google

15.—Calling Device Details.

Digitized by Google

and it may be mentioned in connection with this that the selector and connector relays are adjusted to respond at a higher rate, viz. fifteen per second, and to operate when four bridges each having a condenser in series with a bell are placed across the lines. This is to meet the 4-party line conditions of working. As an indication of the speed of working, when all the apparatus is in order, and assuming, of course, that the necessary circuits are available, it is possible to start a called subscriber's bell ringing within five seconds of commencing to call.

The magneto bell manufactured by the Automatic Co. has a spiral spring controlling the armature. It has been found in practice that difficulties arise in consequence of a tinkling on the bell when

16.—Table Set.

the exchange switchboard attendant makes routine tests at the test-jack. This tinkling is overcome by the slight restraint of the spiral spring.

The electro-magnetic receiver which is in general use on the Automatic Electric Co.'s systems in America is, as its name implies, not fitted with a permanent magnet, and consequently is much lighter to handle than the type in use with the C.B. system in this country.

It consists of a single bobbin of 50ω resistance with a soft iron core, which has a screw threaded extension at one end upon which a U-shaped piece of soft iron is fitted, extending the inner pole piece around the outside of the bobbin on opposite sides. The parts are

Digitized by Google

fixed into a brass cup which fits into a shell of the usual composition.

Referring again to 17, it will be noted that plungers, relays, meters, etc., are all at normal. At the outset, and before detailing the operations, it may be briefly stated that during conversation the following items are in operation.

SUB-STATIONS.—Both receivers are off.

CALLING SUBSCRIBER'S LINE SWITCH.—BCO coil operated, side springs moved over, cut out tell-tale relay and line coil. Plunger contacts made and plunger thrust into bank, meter operated and 50ω coil short-circuited.

SELECTOR.—Line switching relay operated and lines through. Other relays dead. XY contacts made.

CONNECTOR.—Back bridge relay, Line relay, Release relay, Ring cut-off relay } operated. All other relays de-energised.

Side switches to position 3, speaking current supplied to the calling subscriber and called subscriber through the line and back bridge relays.

Tracing the operations from commencement to finish we will consider each separately.

PRIMARY LINE SWITCH (17).

With reference to the primary line switch coils it should be noted that, when energised, the pull-down coil (70ω) actuates armatures "a" and "b." The bridge cut-off coil (1200ω) actuates "a" armature only, but holds "b" when "b" is down. The line coil (94ω) actuates the bottom armature which is retained by the holding coil (6ω).

The subscriber, by lifting the receiver off the hook, loops the + and − lines. The following operations then take place at the primary line switch:

Line coil energised, its armature extension earths the pull-down coil through the tell tale relay *viâ* the side contacts. The holding coil and pull-down coil are then energised from main battery. Both "a" and "b" armatures are pulled down. "a" breaks the line coil and earth away from the subscriber's − and + lines, "b" causes the plunger to enter bank and make the following connections:

(1) Subscriber's + line through to + trunk line, and subscriber's − line through 50ω meter coil to − trunk line.

(2) Battery through bridge cut-off coil to release trunk wire.

(3) 750ω meter coil to release trunk wire.

(4) Master switch bank and hold trunk lines to earth.

Digitized by Google

(5) Normal private wire to release trunk wire.

At the end of the plunger stroke the plunger armature contacts are made. The holding coil is short-circuited, the line coil armature falls back and earth is removed from the pull-down coil. In the meantime, however, battery power has been applied to the — and + trunk lines through the selector line relay coils, relay operated and the release trunk wire earthed. The normal private wire is therefore made busy, and the connector bank multiple guarded against calls from other subscribers. The bridge cut-off coil has also become energised; this holds the plunger in the bank and retains the pull-down coil armature and plunger until the release is effected by the subscriber replacing his receiver.

The main battery through the 750ω meter coil is rendered inoperative by the battery from the selector line relay coils, and the — trunk line through the 50ω meter coils in the opposite direction. When, however, the called subscriber replies, the battery applied to the — and + trunk lines will be reversed and the currents acting together through the two coils operate the meter. The 50ω coil is then short-circuited but the armature is retained by the current flowing through the 750ω coil.

The tell-tale relay is used by the master switch to give alarm when the plunger sticks on the comb, etc.

The operation of the locking magnet will be referred to in explaining the master switch.

SELECTOR (17).

In this, the latest type, as already mentioned, there are no side switches. Its rotary movement commences directly it reaches the level required, and is much more rapid in its operation than the previous type where side switches were used.

When the calling subscriber has been switched through by the primary line switch plunger, the line relay A is energised relay B operated, and release trunk wire earthed.

The subscriber on operating the calling device to call, say, No. 365, first pulls the dial round from figure 3, and breaks his circuit three times.

Relay A armature makes and breaks accordingly. At each break the vertical magnet is operated. The wipers are lifted to the third level. The path of the current is *viâ* release signal line, vertical magnet, relay D coil, and contacts of relays B, C and A. The armature of relay D is adjusted to respond to the first impulse and closes the circuit of relay E, which locks itself *viâ* S and the make contact of relay B to earth.

At the end of the third break at A, D armature falls back and

Digitized by Google

the rotary magnet circuit is now closed, *viâ* R, E, S, and B. The rotary magnet is operated and the wipers move to the first bank contact.

The rotary armature breaks its own circuit at R and S momentarily just after the private wiper taps the private bank contact. The earth at B is thus cut away from the rotary magnet and private wiper circuits, and if the trunk is engaged this private contact will be earthed; consequently the relay E is still energised, and on the restoration of R and S the rotary magnet will again be operated, and so on until an idle trunk is found. Then as the rotary magnet armature breaks the contacts at R and S the private relay circuit is broken, its armature falls back, cutting out both itself and the rotary magnet.

As R and S are again made, the line switching relay circuit is closed, *viâ* contact X, E, S and B to earth.

Relay B, being slow acting, holds the earth contact sufficiently long for the line-switching relay to be operated. This relay switches the calling subscriber's lines through to the connector, the connector line relay then operates, and closes the circuit of the release relay, which in turn earths the release trunk wire, which now holds the selector line switching relay and the bridge cut-off coil of the line-switch.

The condensers are provided to absorb the spark which would otherwise take place at the contacts due to the self-induction of the vertical and rotary magnets.

CONNECTOR (17).

This connector is provided with an additional relay, and wired for conversion to back release working when required.

As previously explained, when the subscriber has been switched through by the selector, the line relay is energised, also the release relay, which earths the release trunk wire.

The subscriber operating the calling device for the second figure, No. 6, breaks the circuit six times. The line relay armature falls back and gives six tapping earth contacts to the series and vertical magnet relay circuit. These are operated from battery at contact No. 1 of side switch No. 4. The wipers are lifted to the sixth level. The private relay is energised, its circuit being closed at the make contact of the series relay. Contacts X and Y are also made directly the vertical shaft is lifted.

At the end of the sixth signal the series relay and private relay armatures fall back. The release of the private relay causes the four side switches to be each shifted to its second contact point by a mechanical operation.

Digitized by Google

The subscriber now operates the calling device for the third figure, No. 5, and breaks the circuit five times. The rotary magnet is energised accordingly. The series and private relay circuits are also closed. The rotary magnet shifts the private wiper along to the fifth contact.

If this circuit is engaged, then when the series relay falls back the private relay circuit will still be closed *viâ* the break contacts of the series and busy relays to the second contact of side switch No. 1, private wiper, and the engaged earth on bank contact. The busy relay locks both itself and the private relay, *viâ* the normal spring contacts X, which closed with the first vertical step. This breaks the rotary magnet circuit and joins up the busy tone to the calling subscriber's + line *viâ* side switch No. 2, contact point 2.

The calling subscriber clears by breaking the loop, the line relay is de-energised, and the release magnet is energised *viâ* normal springs Y and release and line relay contacts. The release magnet strikes away the double dog, and the shaft rotates back and falls.

If the called subscriber is disengaged the private relay circuit is broken, and, falling back, shifts the side switches to their third contacts.

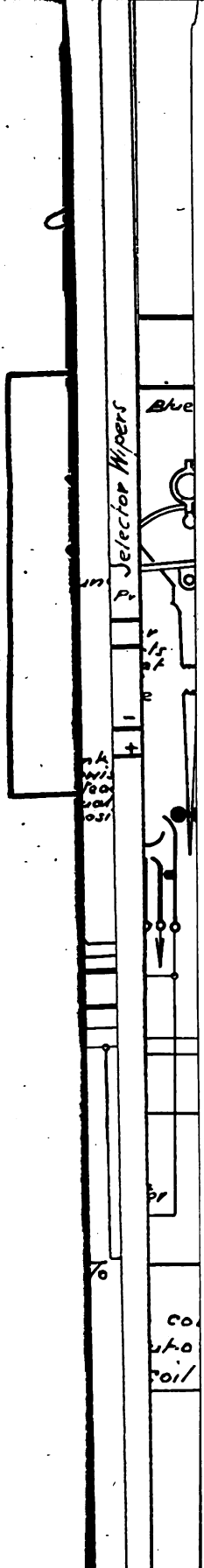
The called subscriber's private bank is now earthed at side switch No. 1, contact 3, and made busy to other calls. This operates the bridge-cut-off relay at the called subscriber's line switch; the armature "a" is pulled down, but not the plunger. The — normal is thus connected to the — line outgoing to the subscriber.

The ringing relay is now operated from the battery at side switch No. 4 through the third contact point to ringing relay, contact of ring-cut-off relay to interrupter earth. This periodically cuts off the calling subscriber's side and places the generator across the called subscriber's lines. The make and break of this relay is heard by the calling subscriber. This fact undoubtedly has a speeding-up effect on the called subscriber. The called subscriber replies, and at the occurrence of the next non-ringing interval the called subscriber's loop causes the back bridge relay to come into operation. One of its armatures closes the circuit of the ring cut-off relay, which is operated and locked, preventing any further ringing. The other two armatures reverse the battery going out to the calling subscriber, operating his meter, which locks itself.

Speaking current is supplied to the called subscriber through back bridge relay coils, and condensers are interposed between the subscriber's lines. The subscribers then converse.

If the called subscriber hangs up his receiver prematurely the connection is not broken down; the back bridge relay is de-energised and battery to calling subscriber is reversed. On again lifting his

Digitized by Google



Digitized by Google

fig
is
als
th

th
th
I,
rei
co
th
su

is
sp
st
fa

br
cc

N
br
tu
th

N
ri
ca
su
ca
oi
oc
lc
it
oj
aı
oj

b
su

c
a

I

Digitized by Google

receiver the battery is once more reversed, but no further registration takes place.

When the calling subscriber clears, the release magnet is operated its circuit being closed at Y and the break contacts of the release and line relays. The wiper shaft then rotates and falls.

Simultaneously with this release action the release relay removes the earth connections from the release trunk wire. The selector switching relay falls back, operating the release magnet; also the bridge cut-off coil of the calling subscriber's line switch is de-energised and the plunger is withdrawn from the bank.

The bridge cut-off coil of the *called* subscriber is also de-energised. If, however, he is slower in restoring his receiver, this inaction will cause his line relay to operate, and plunge him through to a first selector until he clears.

It may perhaps be pointed out here that the object of taking the — normal to a spring instead of direct to the subscriber's line (as is done with the + normal) is to prevent the generator finding a circuit through the line coil. There is a possible chance of the bridge cut-off coil not operating quickly enough to cut out the line relay, and the generator might thus find a path from the + line to earth *viâ* the tell-tale relay, and back again through the battery and line coil, operating this and causing the plunger to enter the bank and hang up a first selector.

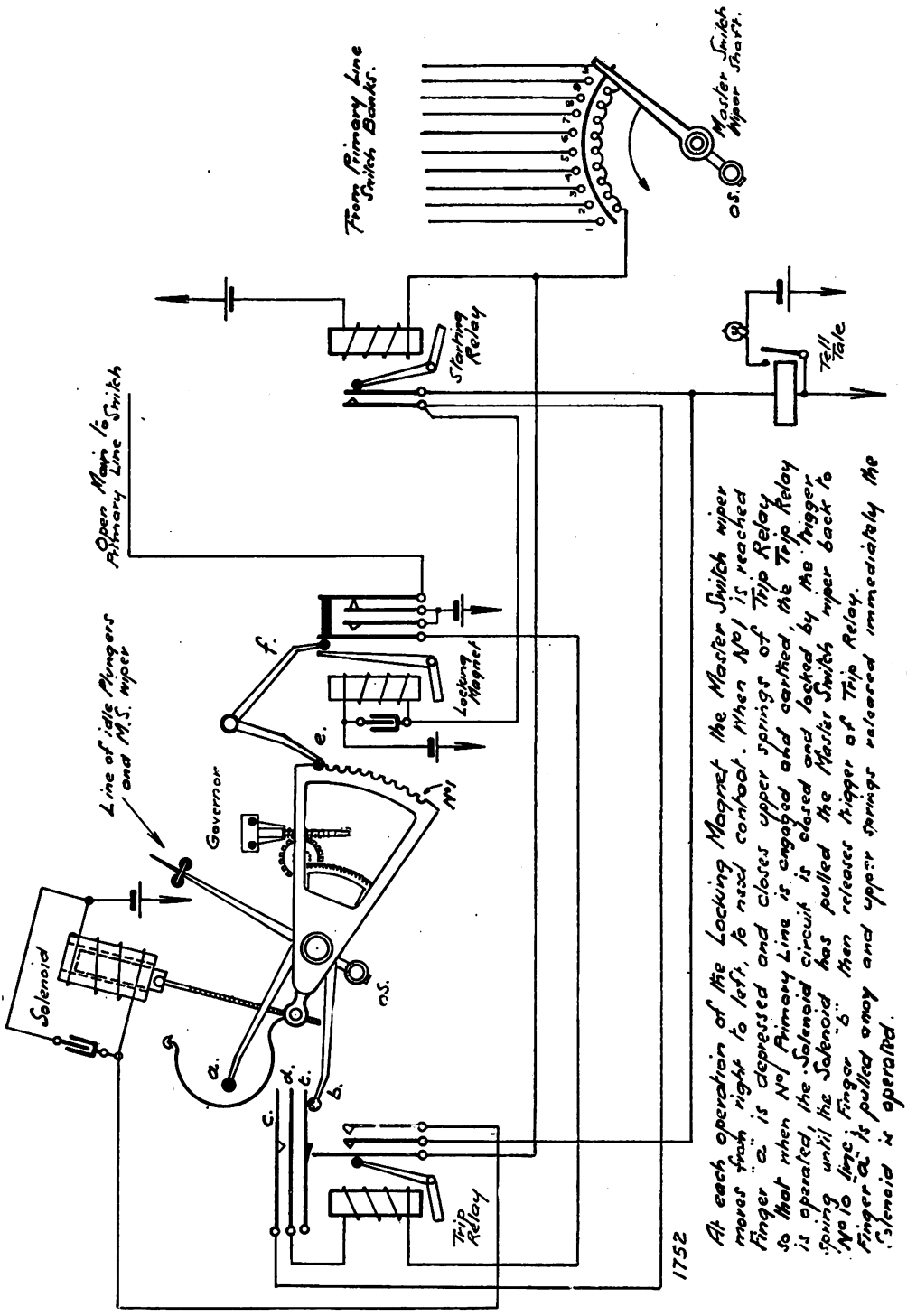
Back Release Arrangement.—It will be observed that the connector has been wired for conversion to back release when required. If the wedge is removed from the back release relay armature the connection will be severed by the called subscriber if he restores before the calling subscriber. The back bridge relay on becoming de-energised closes the back release relay circuit, the path of the current being as follows: Battery, back release relay, ring cut-off armature, back bridge relay armature to earth at side switch No. 1, third contact. This would break the earth connection away from the release trunk wire and de-energise the selector line switching relay, which in turn would cause the breakdown of the selector and connector and the withdrawal of the plunger.

Reversal of Current.—Where meters are not fitted, as is the case in the official switch, this reversal is still required for supervisory purposes in the cord circuits of the manual switchboard.

Master Switch (7 and 18).

The master switch wiper, which is fixed at the base of the line switch unit, is coupled to the crank shaft 0S, whose movement is controlled by the notched quadrant.

Digitized by Google



18.—Diagram of Solenoid Master Switch.

At each operation of the Locking Magnet the Master Switch wiper moves from right to left, to next contact. When No1 is reached finger "a" is depressed and closes upper springs of Trip Relay so that when No1 Primary Line is engaged and earthed the Trip Relay is operated, the Solenoid circuit is closed and locked by the trigger finger until the Solenoid has pulled the Master Switch wiper back to No10 line finger "b" then releases trigger of Trip Relay. Finger "a" is pulled away and upper springs released immediately the Solenoid is operated.

Digitized by Google

Rigidly attached to this quadrant is a small toothed segment which engages with the pinion wheel of the worm screw of the centrifugal speed governor. Fingers *a* and *b* also move with the quadrant. The crank shaft os has a knife edge over which the fantail discs of the plungers fit in their normal position. They are thus held in the same vertical plane as the master switch wiper; consequently all the disengaged line switch plungers are moved with the master switch wiper and rest opposite the bank contacts immediately above the disengaged trunk line.

The hoop spring tends to turn the quadrant and pull out the shaft of the solenoid, but is checked by the stop pin *e*.

It will be seen that when No. 10 selector is engaged, line No. 10 is earthed at the primary line switch, the starting relay is operated, and this in turn operates the locking magnet, one of whose armature springs breaks the open main battery circuit to the line switch and prevents any plunger being actuated during the movement of the shaft. The make contact of the other armature spring connects the battery to the trip relay coil, but this circuit is broken at its own spring *d*.

The locking magnet armature strikes the crank *f* lifting the stop pin *e*, and allowing the notched quadrant to move one step. The speed of this movement is controlled by the governor.

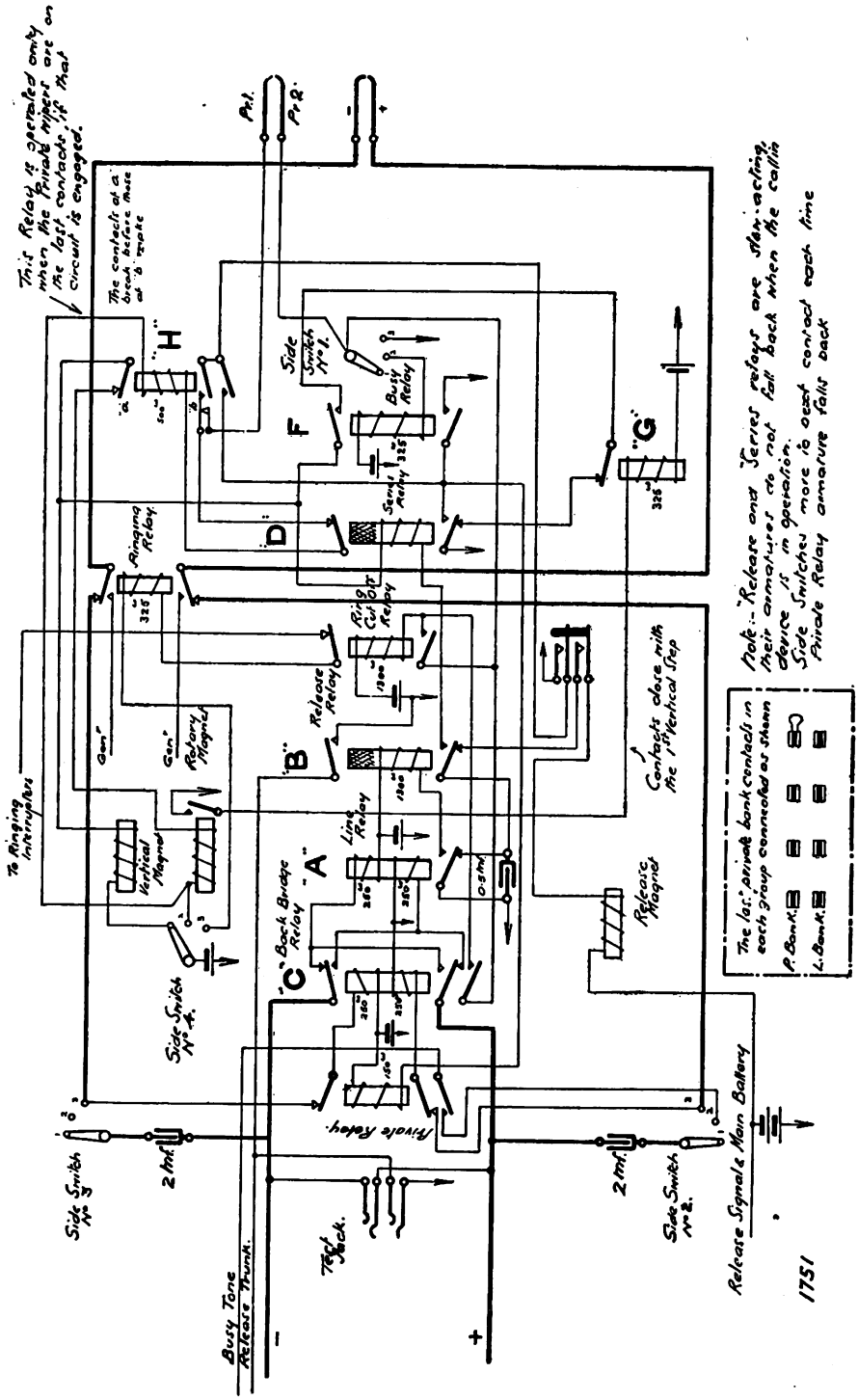
The master switch wiper is thus moved to No. 9. If this is disengaged the starting relay and the locking magnet are de-energised and the stop pin *e* falls into No. 9 notch.

If No. 9 is busy these relays will be again operated, moving the plungers to opposite No. 8, and so on.

When the master switch wiper is on No. 1, the notched quadrant will have moved round so that the stop pin is in No. 1 notch and the finger *a* will press springs *c* and *d* together. Immediately No. 1 line is brought into use and earthed the starting relay and locking magnet will be operated. This in turn closes the trip relay circuit. The trip relay armature is operated and its three side springs locked into contact by the trigger spring *t*, closing the starting relay and solenoid circuits through the tell-tale relay. The locking magnet is kept energised and the stop pin held up, while the solenoid pulls back the notched quadrant and with it the master switch wiper to No. 10. Finger *b* then strikes the trigger spring and releases the trip relay side springs.

If all the selectors are engaged the master switch is kept moving to and fro. Should a subscriber call during this period it appears quite possible that he may signal his first digit before obtaining the use of a selector. A little consideration of the switching scheme plan will show that he may reach a two-figure number, *i. e.* a manual exchange, or land on a connector level without reaching a bank

Digitized by Google


This Relay is operated only when the Private wipers are on the last contacts of their Circuit is engaged.
The contacts of a break before make at "B" make
P.1.
P.2.
"H"
Side Switch No 1.
Busy Relay
Send Relay
"F"
"G"
Ringing Relay
"D"
Ring Cut Off Relay
Release Relay
"B"
Gen. Rotary Magnet
Gen. Vertical Magnet
To Ringing Interrupter
Line Relay
"A"
Contacts close with the 1st Vertical Step
Release Magnet
"C" Back Bridge Relay
Side Switch No 4.
Private Relay.
Side Switch No 3
2 Mf.
Test Jack.
Busy Tone
Release Trunk.
2 Mf.
Side Switch No 2.
Release Signals Main Battery
The last private bank contacts in each group connected as shown
P. Bank.
1. Bank.
Note:- Release and Series relays are slow acting their armatures do not fall back when the calling device is in operation.
Side Switches may be used contact each time Private Relay armature falls back
1751

19.—Rotary Connector.

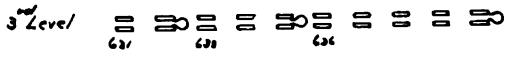
Digitized by Google

contact. In the former case the operator would reply. In the latter case, on receiving no reply he should hang up and proceed to call again.

Rotary Connector for Private Branch Exchange Lines (19).

Private branch exchanges with more than one circuit are connected to a line switch unit equipped with rotary connectors, so arranged that if the first circuit of the system is busy, the wipers pass to the second circuit, and so on. If all are engaged, a busy tone is given on reaching the last line. The private bank contacts of this line are looped as shown in the inset, where one group of four lines is shown.

One level is not limited to one Branch Exchange system; there may be several connected to the same level as in **20**, where say A, B and C have 2, 3 and 5 lines respectively. Only one exchange No. is given to each system, and is that number of the bank contact to

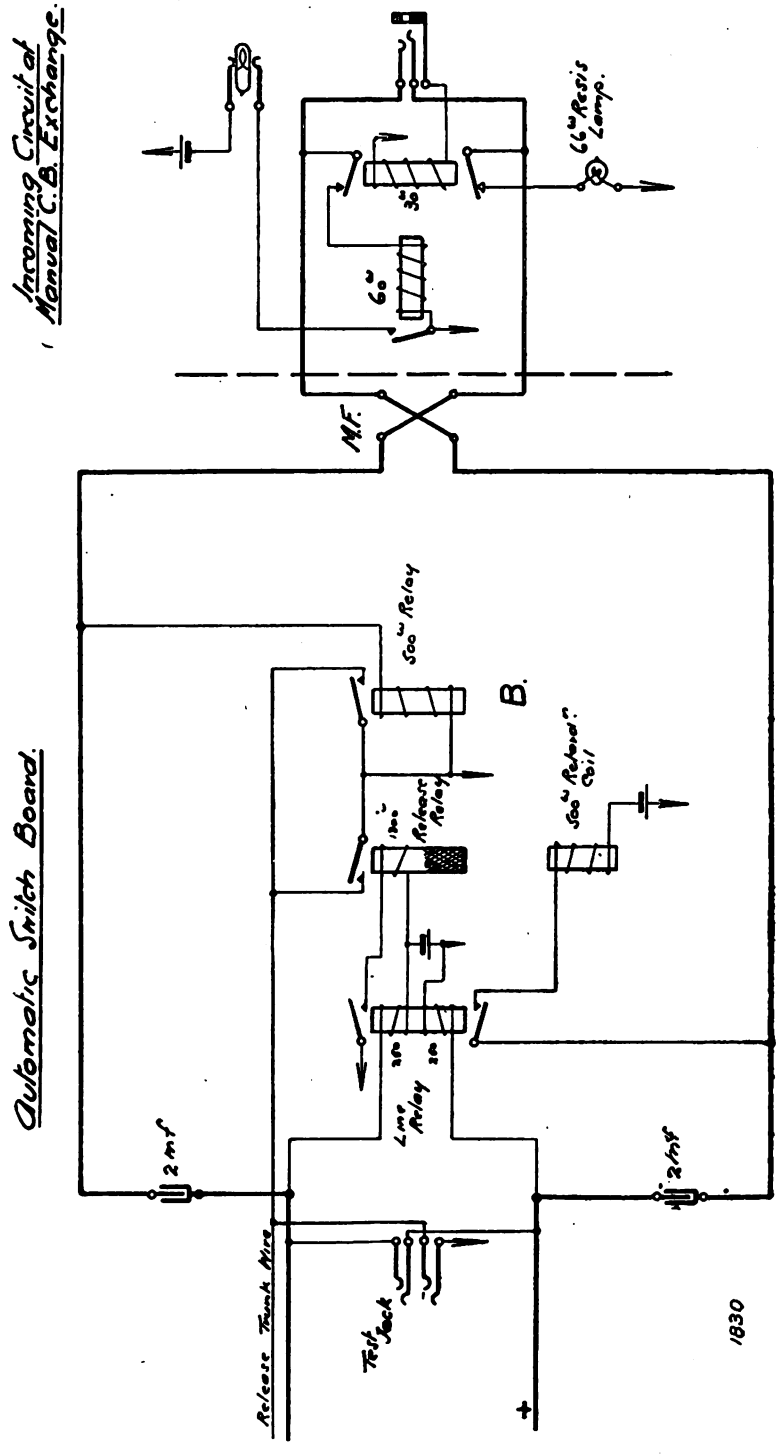


20.—One Level of Rotary Connector showing Three Groups of Private Branch Exchanges.

which the first line is connected. In the example given the numbers would be A = 631, B = 633, and C = 636. It should be pointed out that the lower contact of the private pair is the test wire in the rotary connectors. If Private Branch Exchange No. 636 is required, then when the wipers reach the third level, the rotary magnet will respond to the units digit of six impulses and pass over the five contacts of A and B to 636. If engaged the busy relay will be operated and the private magnet held up. As soon as the series relay armature falls back, the rotary magnet circuit will be closed, *viâ* "*a*," F, G and D armatures, the wipers will be shifted to the next position, and so on. G relay is energised each time the rotary magnet operates, thus causing a make-and-break action which continues until the busy relay is de-energised in consequence of the wipers finding no earth.

If, however, the last bank contact is reached and found to be engaged, the circuit of relay H will be closed *viâ* SS *4* contact *2*, H, D, *b* and the loop across *Pr 1* and *Pr 2* to the earth on the private bank. The private magnet is held up and the busy tone is heard by the caller.

Digitized by Google



21.—Outgoing Junction to Manual C.B. Exchange.

Digitized by Google

Calls Outgoing to Manual Exchanges (21).

The subscriber calls, say, 17 for Sutton Exchange, and taps an idle outgoing junction from the seventh level of the second selector. The subscriber's loop then energises the repeater circuit line relay, one armature of which closes the release relay circuit and so earths the release trunk wire. The operation of the other armature causes battery to be applied through the 500ω retardation coil to the tip or A line, operating the line relay at the A position and lighting the lamp there.

The A operator plugs in her answering peg, operating the cut-off relay. The common battery from her cord circuit being then connected to the B line or ring of the jack operates the 500ω relay B of the repeater circuit, which places a holding earth connection on the release trunk wire. The supervisory relay of her cord circuit is operated by the battery through the 500ω retardation coil of the repeater circuit, so long as the automatic subscriber has his receiver off, and the supervisory lamp is darkened.

The required connection is then given in the usual way by the A operator, and the call ticketed.

When the automatic subscriber restores his receiver the repeater line relay is de-energised, the armature falling back removes the battery from the A line and the lamp glows at the manual exchange, but this action of the calling subscriber does not sever the circuit, as the 500ω relay B is still energised from the battery over the B line of the A operator's cord circuit and the earth is maintained on the release trunk wire, so that if there is any suspicion as to the origin of the call, as well as for other reasons, the circuit can be held by keeping the plug in the jack until the Epsom test clerk has been advised and the call traced back to its source. This is a very necessary precaution.

When the plug is withdrawn the circuit of the line switching relay of the second selector will be opened and the release magnet will come into operation.

It will be noticed that there is no reversal of current over the calling subscriber's lines when the C.B. manual operator replies, consequently the meter does not register a call. This, however, can be arranged for by replacing relay B by one similar to the back bridge relay of the connector and wiring the connections to suit.

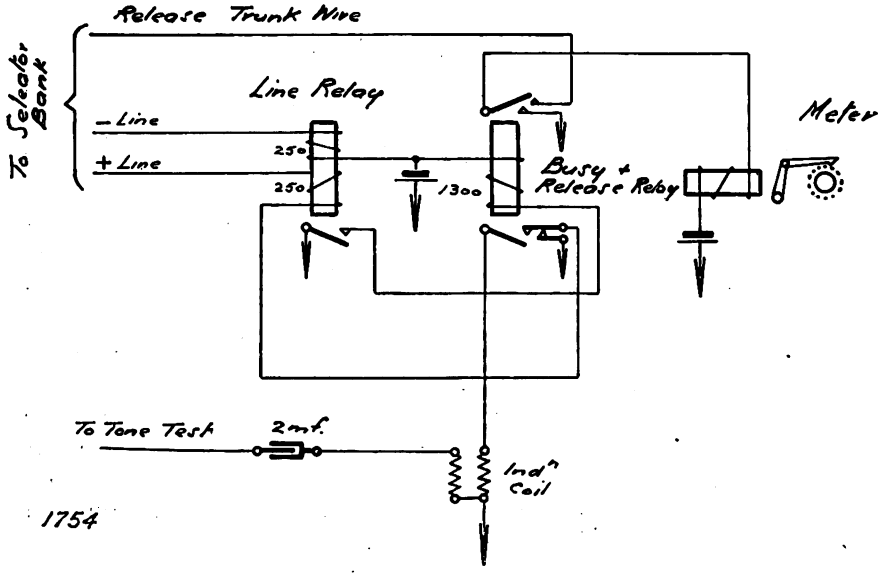
Junction Busy Back with Meter (22).

This circuit when connected to a dead bank contact of a selector level will give a busy tone when tapped and also record the ineffective call.

Digitized by Google

It is useful for ascertaining how far the junctions provided, fail to cope with the traffic during any period of time.

For instance, if multipled to the fifth bank contact of the seventh level of the second selectors, then when each of the four junctions to Sutton are engaged, the wipers will tap the fifth contact, the line and busy relays and meter will be operated, and the caller will receive the busy tone.



22.—JUNCTION BUSY BACK WITH METER.

* * * *

The Test and Offering Connectors and the arrangements made for dealing with Dead Levels, and Dead Numbers, will be described when considering the Test Desk and Manual Switchboard.

PART III.

Before proceeding to discuss the auxiliary items, such as the test desk and manual switchboard, it may be well to consider the power plant, the ringing circuit, and the supervisory alarm signals.

The *power plant* occupies two rooms in the basement. Only one main battery is provided, consisting of 25 cells of the chloride type, having a present capacity of 120 ampère-hours and an ultimate capacity of 240 A.H. In order to keep the voltage at the bus bars constant, 7 counter E.M.F. cells and a special switch, as in 23, are also provided, so arranged that one or more of these cells can be switched into the discharge circuit of, and in opposition to, the main battery during charging, and be cut out of circuit as the main battery voltage falls during discharge. It is essential to the satisfactory

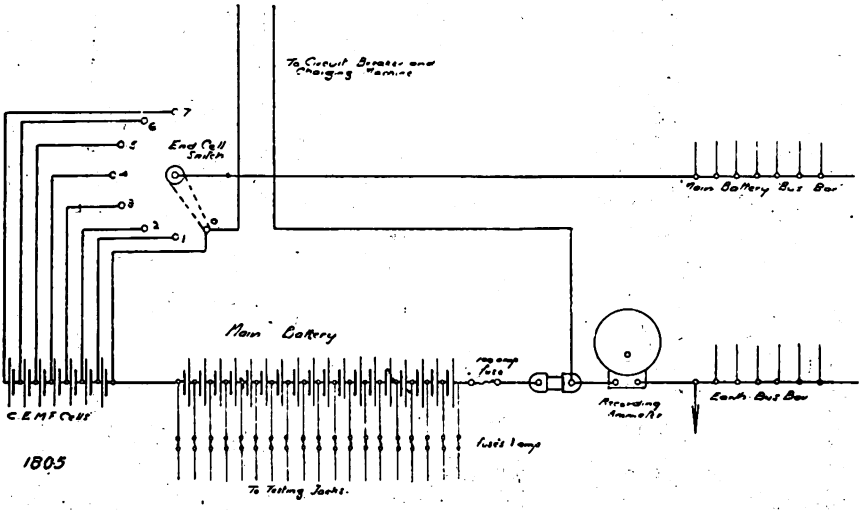
Digitized by Google

working of the apparatus that the voltage at the bus bars shall be kept within the limits of 46 to 49 volts.

As charging takes place during the working hours of the exchange the specification provided for a noiseless generator, so that a steady charging current can be furnished and no disturbing noises introduced into the system.

24 is a view of the power board. The panels are of Tennessee marble.

The four cases fitted in the upper portion of the left-hand panel contain the two ringing interruptors and the two sets of pole changers, vibrators and busy-back. These are interesting as they differ from British Post Office practice. The throw-over switch is for the



23.—Arrangement of Main Battery and E.M.F. Cells.

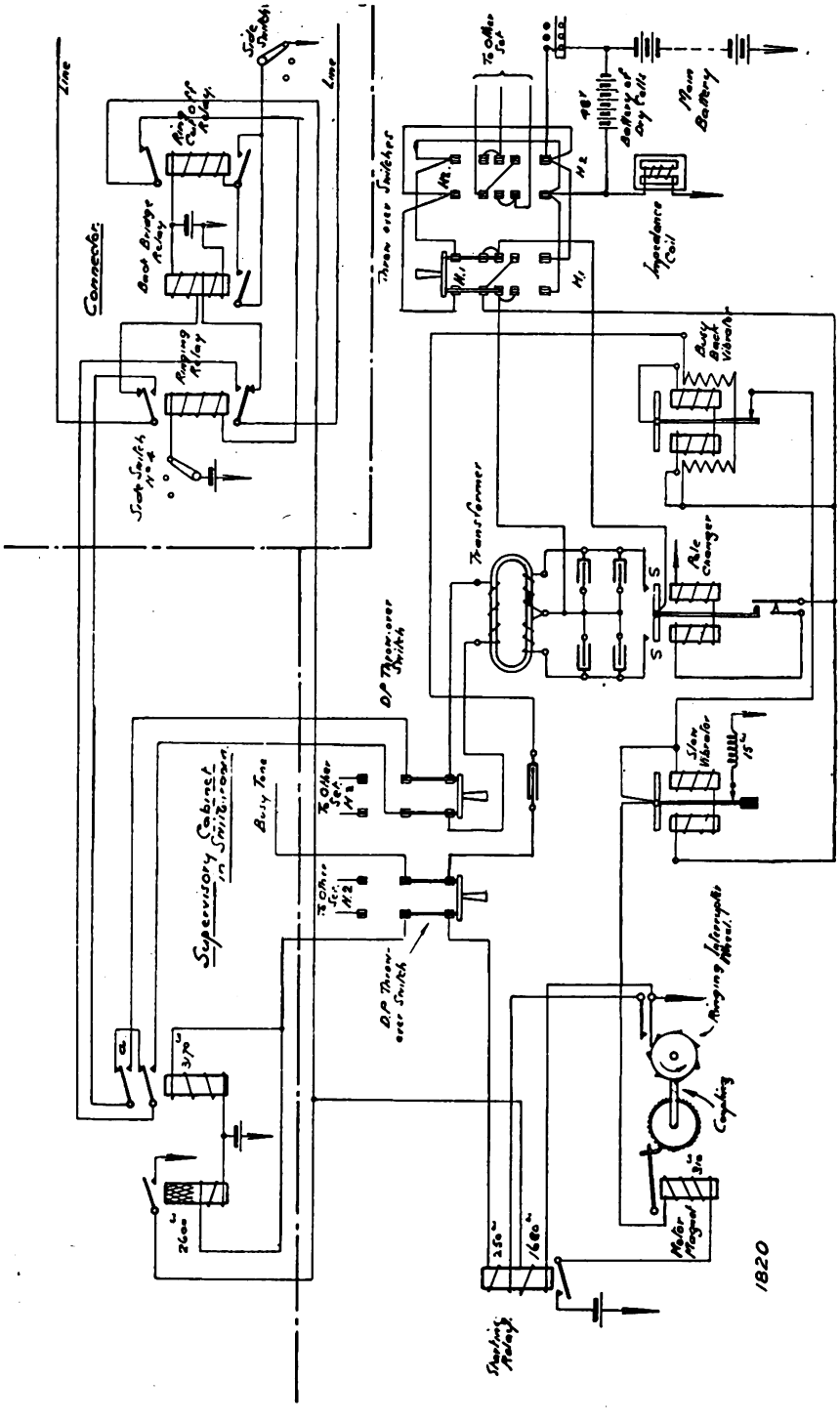
purpose of daily reversing the direction of the current at the contacts of the pole changer.

On the extreme right-hand panel are fitted the fuses for the manual switchboard and test desk.

Ringing Circuit (25).—When the connector side switch No. 4 shifts to the third contact, as shown in the diagram, the battery finds a path through the ringing relay, ring cut-off relay contact and the 1680ω coil of the starting relay to earth at the ringing interrupter wheel. The starting relay is operated, the motor magnet energised, and the ringing interrupter wheel rotated with periodic movements due to the slow acting vibrator. The connector ringing relay is not operated through 1680ω, but immediately a tooth of the ringing interrupter wheel brings the springs into contact the 2600ω and 3170ω relays are energised *viâ* the 250ω coil of the starting relay. The ringing relay is also operated *viâ* the direct earth contact at the

Digitized by Google

Digitized by Google



25.— Ringing Circuit.

Digitized by Google

It will be noticed that when the 3170ω relay falls back at the periodic breaks the — and + lines are short-circuited at the armature loop *a*. The object of this loop is to form a path for the discharge from the condensers on 4-party line circuits. This discharge would otherwise pass through the back bridge relay, and there is a possibility of the ring cut-off relay being operated and further ringing prevented. The slow-acting 2600ω relay is provided to keep the ringing relay circuits closed during this discharge.

The ringing impulses are provided from the secondary of a transformer coil, whose primary is in a pole-changer circuit. As this is worked from the main battery a "noise killer" is provided consisting of an impedance coil and a battery of dry cells.

Supervisory Alarm Signals.

In an automatic exchange it is essential that any failure in the electrical or mechanical parts of the system should be immediately notified and remedied.

The following are some of the arrangements made:—

Line Switch Unit Alarm (26).

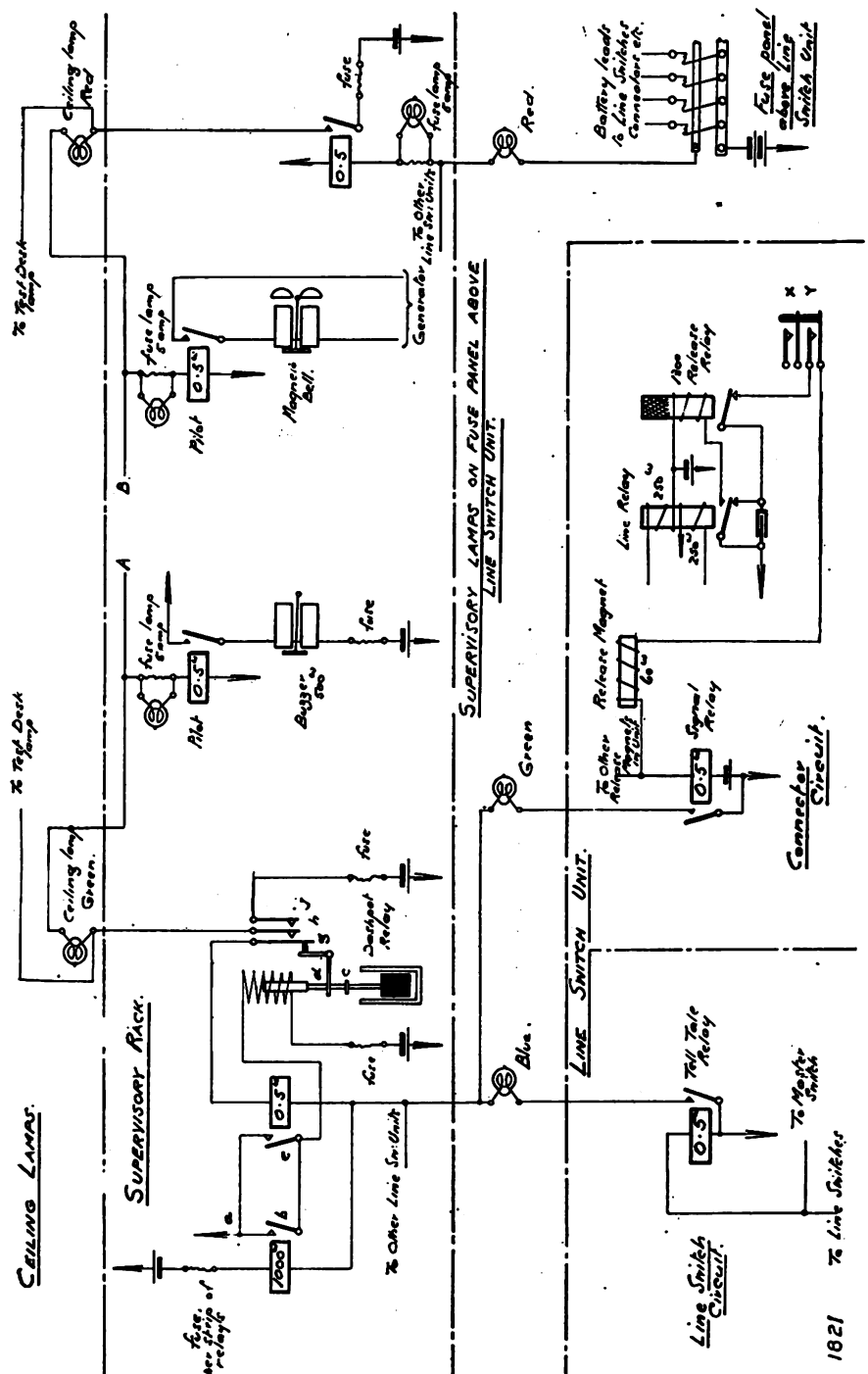
Wiper shaft not properly released.—When working satisfactorily the wiper shaft is released in a fraction of a second and the connector is free to take up another call. If, however, through some want of adjustment this does not take place, not only is the connector thrown out of use but the current through the release magnet is likely to cause overheating in the coils.

When the clear signal is given the release magnet circuit is closed *viâ* the signal relay, release magnet, off normal springs Y and break contacts of release and line relays. The contacts at Y are only broken when the wiper shaft has fallen to its normal position, so that should it stick in any mid-position the signal relay will become energised and its armature closing the 1000ω relay circuit brings the dashpot relay into operation. The core of this relay with its extension shaft is sucked up slowly, and at the end of four or five seconds the collar C reaches and lifts up lever d, pressing springs *g*, *h* and *j* into contact.

Battery is applied through *j*, the green ceiling lamp and its corresponding lamp on the test desk glow, the pilot relay is energised, and the buzzer is brought into action until the trouble is cleared. The green lamp above the line switch unit concerned also glows as the 1000ω relay is now shunted by the dashpot 0·5ω relay, *viâ* spring "*g*." This relay maintains the circuit of the dashpot relay when the armature of the 1000ω relay falls back.

A fuse shunted by a lamp safeguards the pilot relay circuit.

Digitized by Google



26.—Line Switch Unit Alarm Circuits.

Digitized by Google

Master switch unable to find a disengaged selector.—One tell-tale relay is common to 100 line swiches and their corresponding master switches.

Thus when all the ten selector lines in one group are engaged, the master switch wiper moves to and fro continuously. In this case the blue lamp glows above the unit concerned when the dashpot relay brings the green ceiling lamp and buzzer into operation.

Apart from the desirability of knowing when all the channels are blocked in advance of a subscriber originating a call, this alarm is necessary so that the attendant may ascertain whether the block is caused by faulty lines, or subscribers' receivers being off and first selectors being engaged to no useful purpose.

This can be readily ascertained, as will be explained later, and he will then plug such lines out of circuit and release the selectors.

Blown-fuses.—The power leads to the line-switches and connectors are fed through fuses of the usual alarm type placed on the panel at the top of each unit. A blown fuse causes a red lamp to glow above the panel concerned. A red ceiling-lamp and a magneto bell are also brought into operation, calling for immediate attention.

Called subscriber tied up by calling subscriber.—By referring to 17 it will be seen that if a supervisory relay is inserted between the battery and the back release relay it will be operated when the called subscriber restores if the calling subscriber has not already effected the release. This supervisory relay would then bring into circuit a dashpot relay with its lamp and buzzer.

Selector Switch-Board Supervisory Signals (27).

(1) *Wiper shaft not properly released.*—The supervisory arrangements are similar to those already described for the connector. Differently coloured lamps are used for locating the particular board and shaft where the trouble has occurred.

(2) *Selector unable to find a disengaged line.*—On reaching the tenth contact the wipers are mechanically stopped, but the rotary magnet continues to make and break, giving an audible signal, and also causing the supervisory alarm to act.

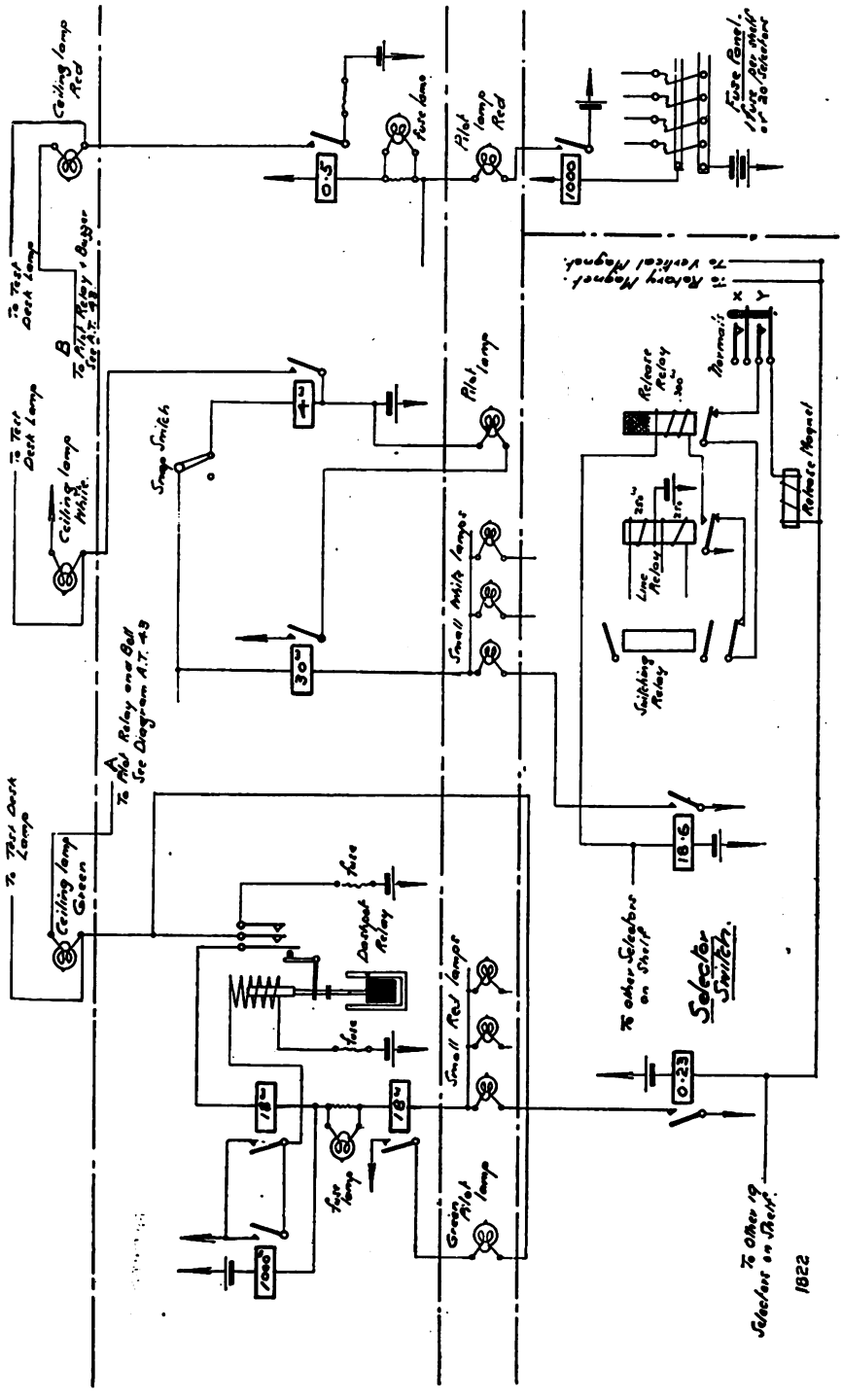
(3) *Blown fuses.*—Similar arrangements as for the line switch-board.

(4) *Selector unnecessarily engaged.*—A first selector is engaged by a receiver being left off, the lines becoming short-circuited, or the B line earthed.

The white ceiling-lamp and the selector-board lamp will glow.

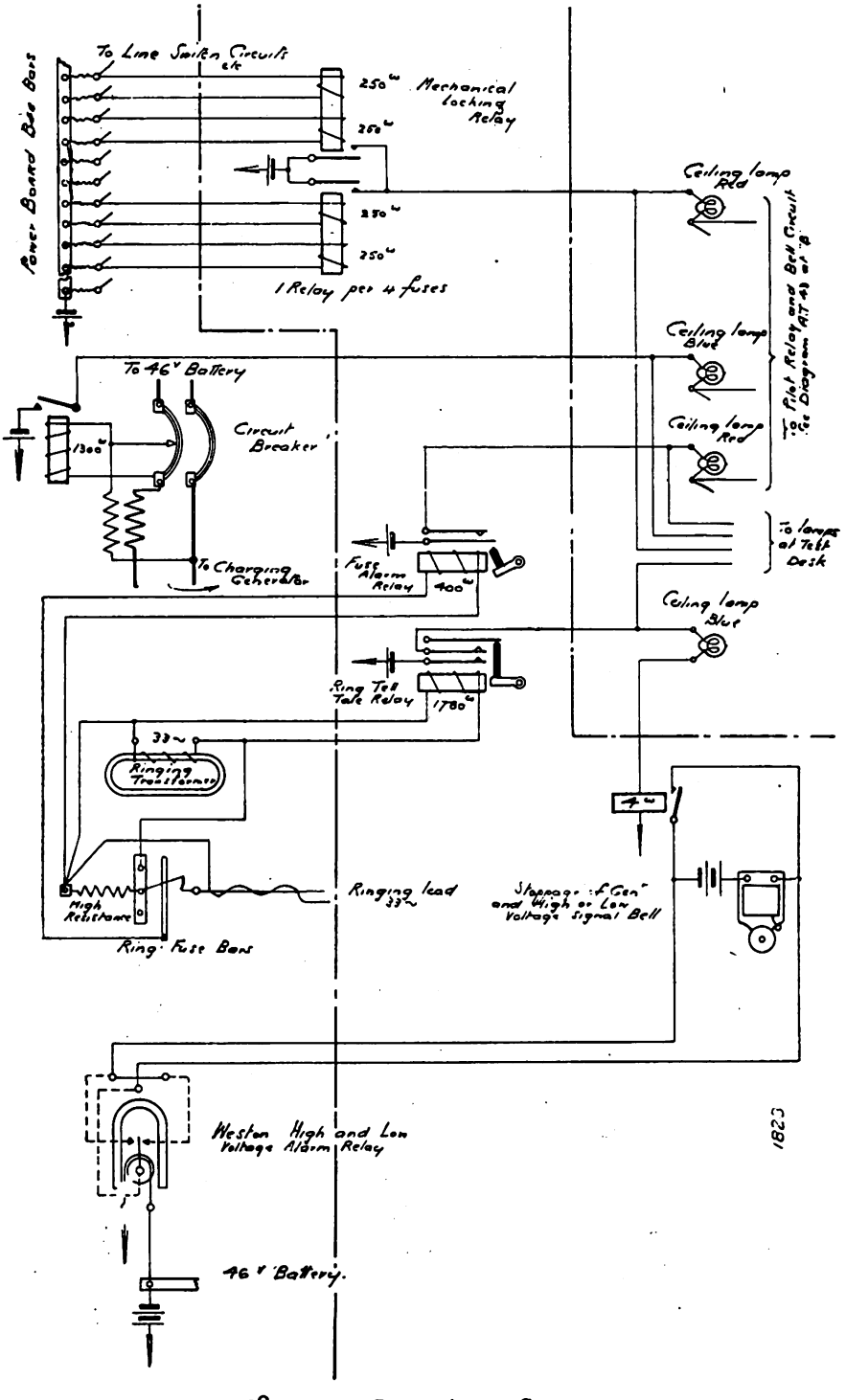
In this circuit a two-way switch is provided. Its normal position is "off," and it is only thrown for testing purposes, as some subscribers remove their receiver before consulting the directory,

Digitized by Google



27.—Selector Switchboard Alarm Circuits.

Digitized by Google



28.—Power Board Alarm Circuits.

Digitized by Google

and in consequence light the supervisory lamp unless cut out by a switch.

Power Board Supervisory Signals (28).

(1) *Power-board fuses.*—The Automatic Co.'s practice is to bridge one coil of a relay across two battery leads. Thus, when a fuse blows, battery is not cut off, but is fed through the 250$^{\omega}$ coil from an adjacent fuse. The relay is operated, a red ceiling-lamp glows, and the magneto bell rings.

(2) *Circuit-breaker operated.*—When the circuit-breaker is operated the 1300$^{\omega}$ relay is energised, a blue ceiling-lamp glows and a bell rings.

(3) *Ringing generator.*—A 1780$^{\omega}$ ring-tell-tale relay, having a slow-acting armature, is permanently bridged across the secondary coil of the ringing transformer. So long as the impulses are generated the tell-tale relay armature is kept in a horizontal position. Immediately the impulses cease, the relay contacts are made, a blue ceiling-lamp glows, and a trembler bell rings.

If a fuse blows in a ringing lead the 400$^{\omega}$ relay is energised, a red ceiling-lamp glows, and a magneto bell is operated.

Battery Voltage Variations.—One Weston Electric Instrument Co.'s high and low voltage alarm relay is bridged across the battery bus bars. If the E.M.F. falls below 46 v. or rises above 49 v. a trembler bell-circuit is closed and an alarm given.

It is understood that in some small exchanges this low voltage contact is used for closing the circuit of a charging rectifier across the battery.

Each one of the ceiling-lamps is multipled to a separate lamp at the test-desk.

Test Desk (29).

Its general appearance is illustrated by 29. There are two positions, one only being equipped. The desk connector which is seen immediately above the calling device is fixed on a slide rail, and when not in use is pushed back into its recess and a glass door closed to protect it from dust.

The functions of the test desk are three-fold:

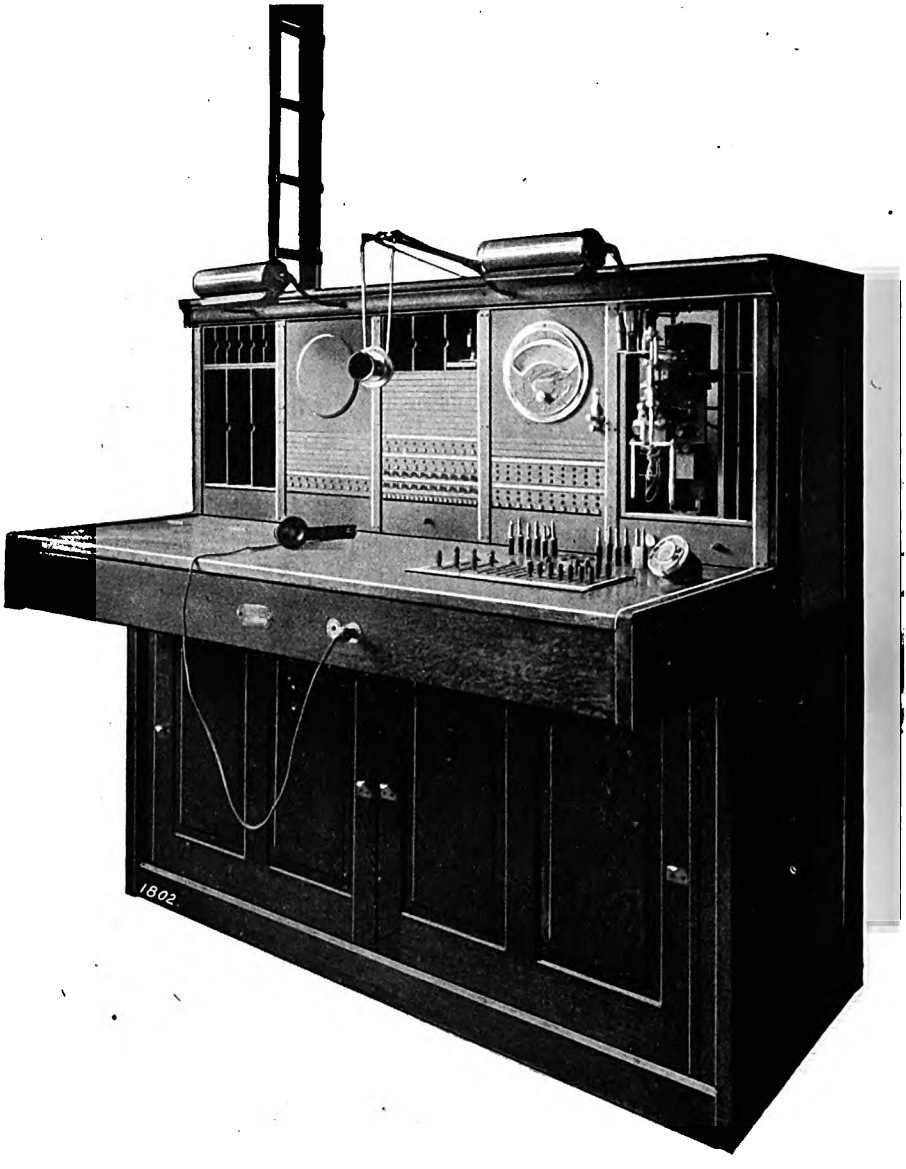
(1) Rapid testing.
(2) Temporary service.
(3) Observation service.

The Test Circuit (30).

As indicated by the lettering of the keys, a variety of tests can be made. The operations are readily understood, and only the following need special comment.

Digitized by Google

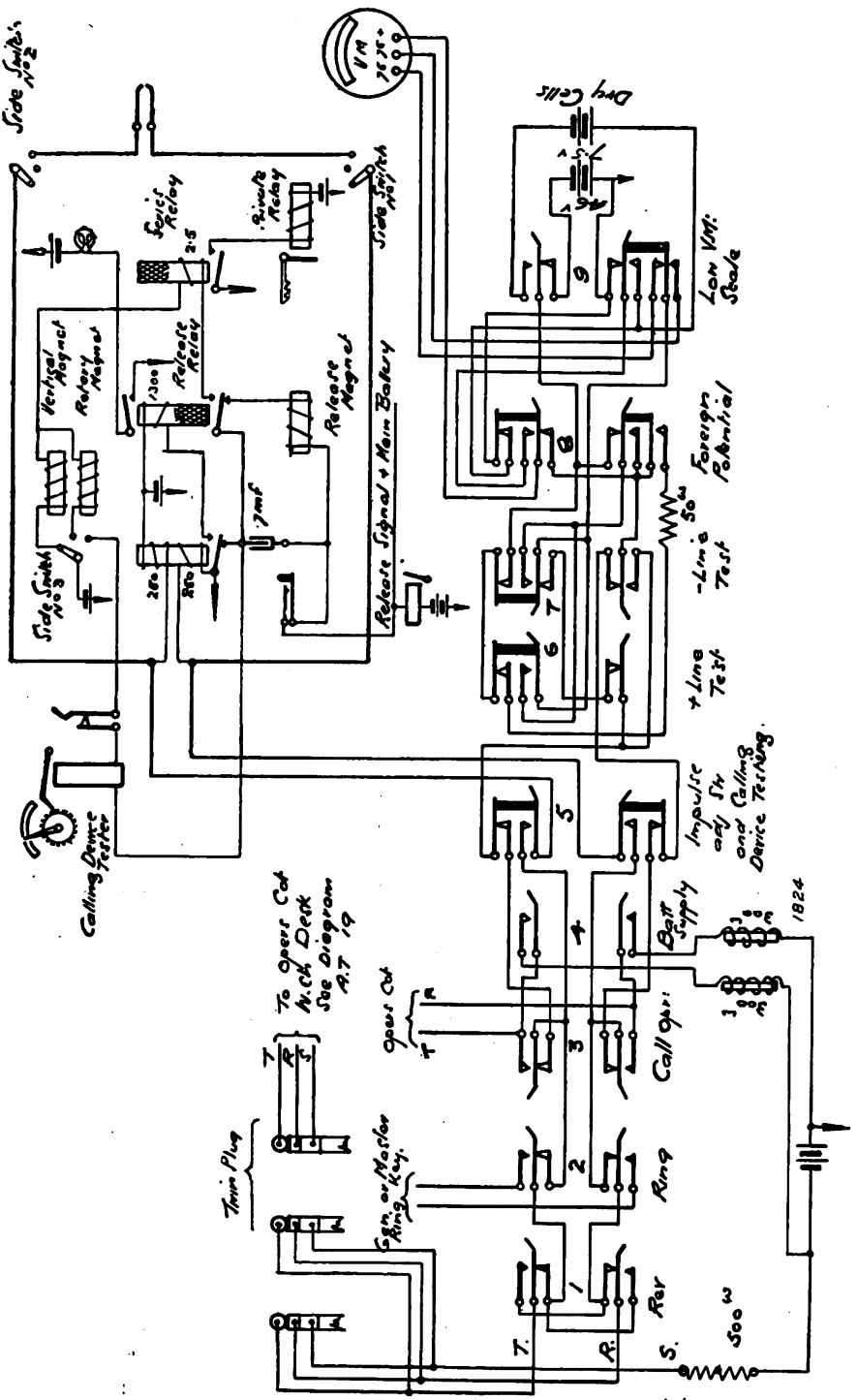
The *impulse adjuster switch* key, when thrown, joins the test desk connector across the test-peg circuit. The test clerk is then able to



29.—Epsom Test Desk.

test the operation of a subscriber's calling device by noting the movement of the wipers in response to a request for any given number. The third series of impulses signalled is 10. *S.S. No. 3* will then be on contact 3 and the impulses will be received at the

Digitized by Google

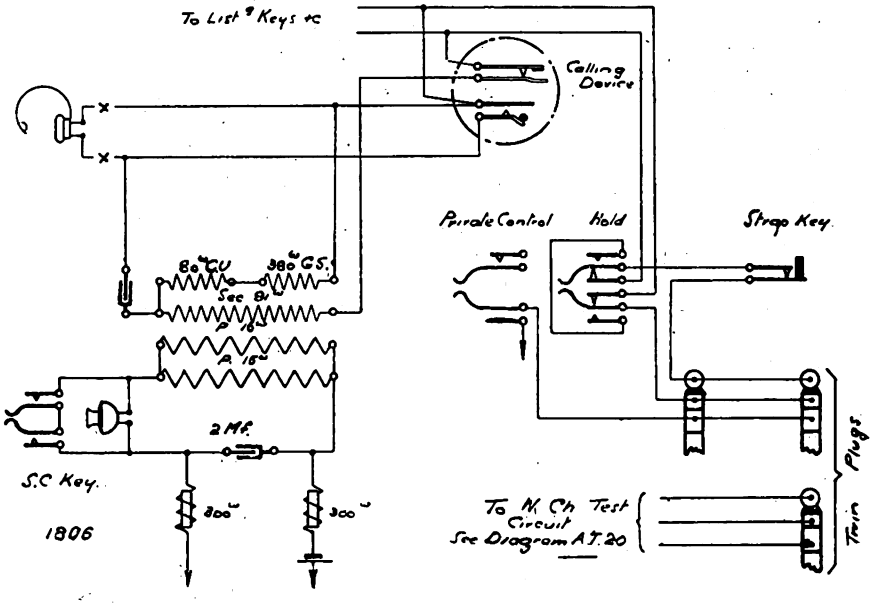


30.—Test Circuit.

Digitized by Google

calling device tester, which is a combined mechanical and electro-magnetic apparatus for comparing the speed of the subscriber's calling device with standard speed. The mechanical portion is wound up by moving a lever over. This action also restores the two pointers to zero. The first impulse releases the mechanism and if the speed of the calling device is standard the two pointers travel together. If not, then the pointer controlled by the electro-magnetic portion lags behind or moves faster than the mechanical pointer.

This desk connector should not be confused with the test connector.



31.—Test Desk Telephone Circuit.

The test officer's speaking circuit is given in 31.

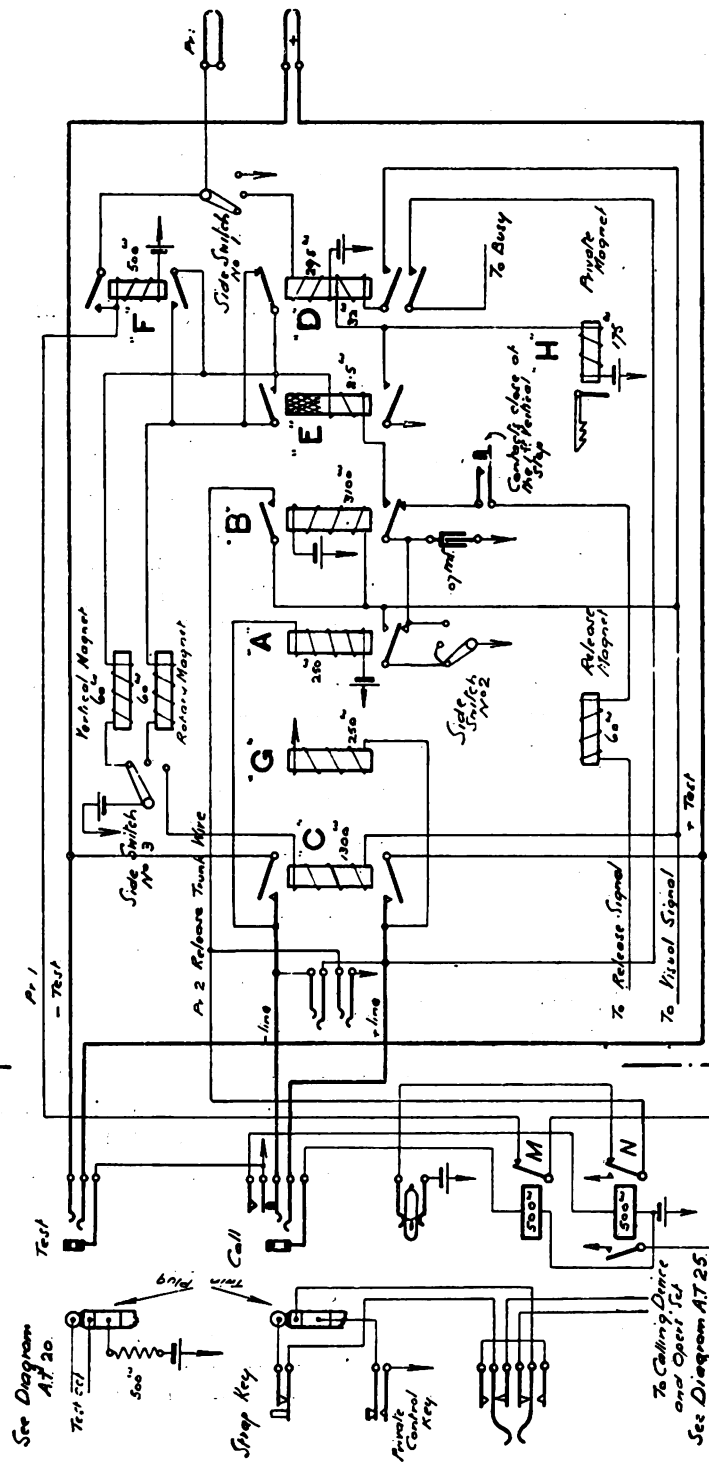
The *twin plug* is used in connection with the test connector.

The Test Connector (32).—One test connector circuit is provided for each 100 subscribers' unit, so that any subscriber's line can be reached direct from the desk and tested without opening the lines at the M.F.

To make a test, the twin plug as shown in 31, and 32 is used, the test and operator's circuit plugs being inserted into the test and call jacks respectively.

Relay N is operated, connecting earth to *Pr 2* and *Pr 1*. The latter closes the circuit of relay F. The test clerk's loop operates relay A. Relay B is then energised (*viâ* A armature and *S.S. No. 2*), and locks itself *viâ* the release trunk wire.

Digitized by Google



32.—Test Connector Circuit.

Digitized by Google

The calling device is operated for the tens digits, the vertical magnet responds, and the side switches move to their second contact. Relay D is energised *viâ* SS *1* and F armature. The rotary magnet responding to the units signals shifts the wipers to the required bank contact and the circuit is made busy, but the side switches are still held at contact No. 2 as the private magnet circuit is maintained after E falls back, *viâ* the 32ω coil of D and B armature to *Pr 2* earth. The B.C.O. coil of the called subscriber's line switch is also operated and the test-jack lines are now through to the subscribers' lines. The test clerk is thus in a position to make tests by means of the cord test circuit and ring up and speak to the subscriber.

The private control key is provided for releasing the B.C.O. coil of the line switch of the subscriber's line under test. By throwing the *Pr* control key, M is operated, and *Pr 1* earth connection broken. D is still held up by the 32ω coil, but F is de-energised. The B.C.O. coil of the subscriber's line switch de-energises and releases the plunger. The subscriber's loop will then operate his line switch and the P.D. coil will in turn operate the plunger and pick up a first selector. If the trouble has been one of "unable to get," the test clerk can then watch the subscriber call up the number he has been unable to obtain and note the result either by leaving his voltmeter across the line or listening in for the reply.

If the Pr. control key is thrown before the test clerk operates his calling device and picks up the subscriber's line, D will not be energised unless the subscriber be engaged. The side switches will move to contact 3, and relay C becoming energised will switch the call jack lines through to the subscriber's lines.

In a large automatic exchange system the test connectors at the small branch exchanges can be operated from the test desk at the Central Automatic Exchange. In such a system the test connectors at the branch exchange are terminated at the bank contacts of a TEST DISTRIBUTOR (sometimes called a test connector selector), which is also located at the branch exchange. The lines from this selector are cabled to the Central Exchange, where the test clerk, by means of his calling device, is able to select and control any particular test connector, and so reach the lines of the branch exchange subscribers.

The test distributor can also be used for tapping the battery leads, taking readings, and if necessary start a charging circuit.

Other circuits are provided, which need no more than a passing reference. These are the usual sounder circuit, howler circuit, incoming and outgoing order-wire circuits, test-jack circuit to the main frame and an extension test-plug circuit to the manual switchboard.

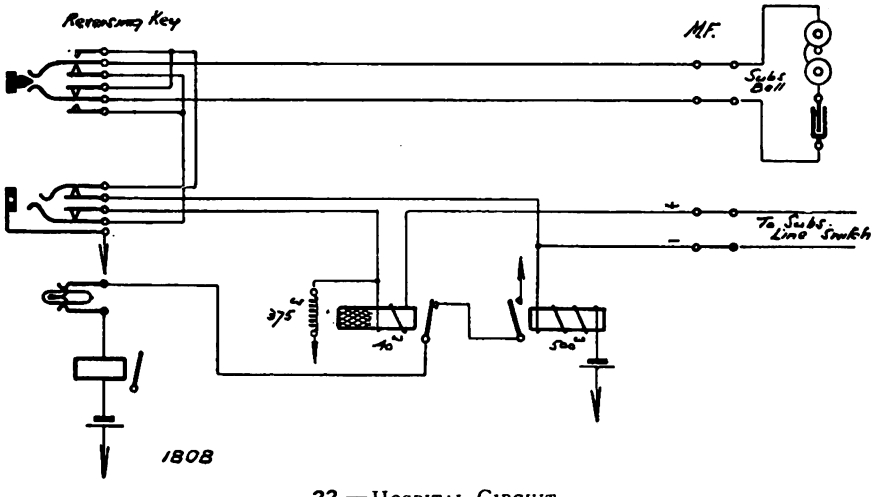
Digitized by Google

Temporary Service.

Faults may occur on subscriber's lines, which, while preventing reliable signalling, may yet be sufficiently good for local speaking purposes.

Such circuits are given temporary service at the test desk by means of a "hospital" circuit (33) and a "hospital" cord circuit (34). The faulty circuit is cut into at the main distributing frame and connected to a hospital circuit. If there is a partial earth on the A line the reversing key in (33) is thrown, thus interposing the subscriber's condenser between the fault and the 500ω calling relay.

On the subscriber lifting his receiver to call, the 500ω relay is energised and the lamp glows. The test clerk plugs in the answering



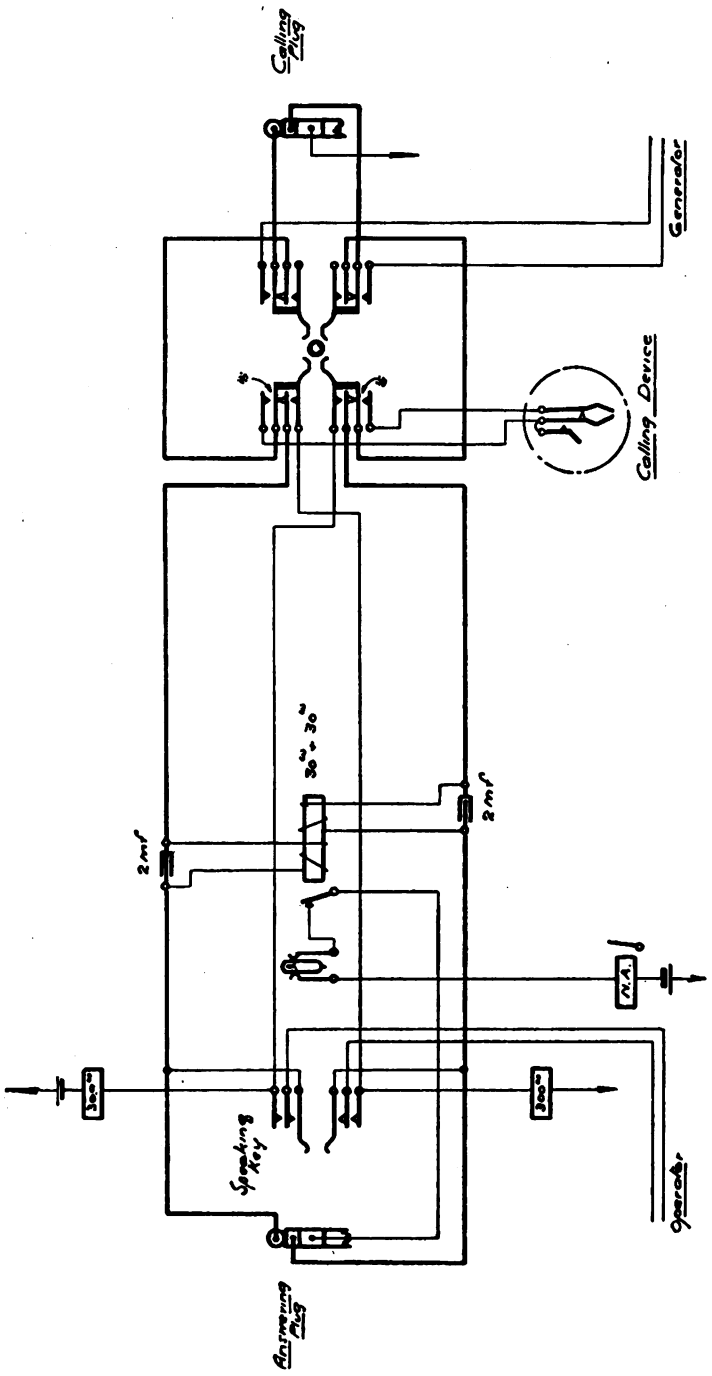
33.—Hospital Circuit.

plug of a hospital cord circuit (34), cutting out the calling relay. The speaking key, when thrown, supplies the speaking battery to the subscriber's line.

To call the subscriber required the calling plug is inserted into the jack of an "in and out circuit" (35), which terminates at a spare line switch as an ordinary subscriber's line. Relay S is operated from the sleeve earth, breaking the circuit of the bridged calling relay B. The calling device key is thrown, and the required subscriber obtained.

During conversation, the speaking current from the connector is in the reverse direction from that supplied through the 300ω relay of the cord circuit when the speaking key is thrown, so that the reversing key on the hospital circuit (33) must now be reset so that the current will pass through the subscriber's telephone before reaching the partial earth fault.

Digitized by Google

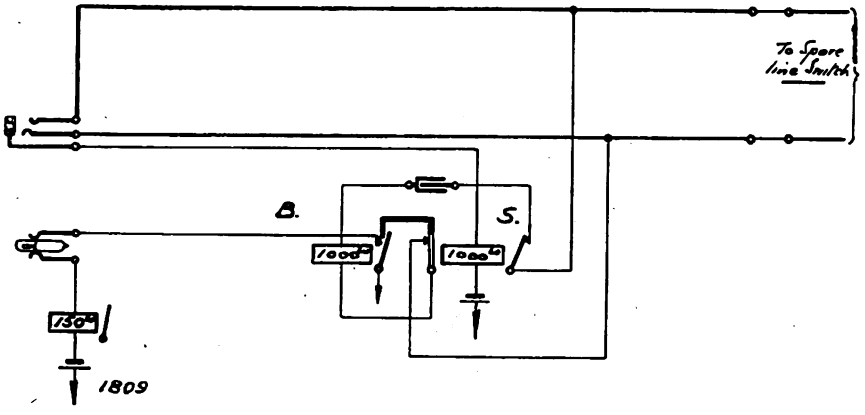


34.—Hospital Cord Circuit.

Digitized by Google

When the subscriber on the faulty line restores his receiver the $30^{\omega} + 30^{\omega}$ relay is de-energised and the clearing signal is received.

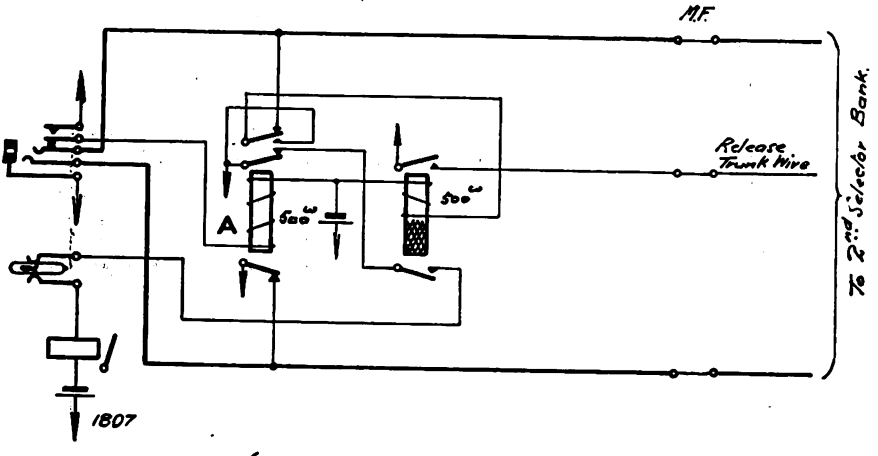
Calls for this class of faulty circuit can, generally speaking, pass



35.—In and Out Circuit.

forward without assistance from the test clerk. The main strength of the generator impulses from the calling connector pass through the subscriber's bell, who is thus rung up direct.

Calls for the test desk are received over a circuit, as given in 36.



36.—Circuit from Selector Levels.

The calling station dials *9*, reaches the ninth level of a first selector, and taps an idle circuit. The slow-acting relay is operated, the lamp glows, and the release trunk wire is earthed, holding the selector line switching relay, etc.

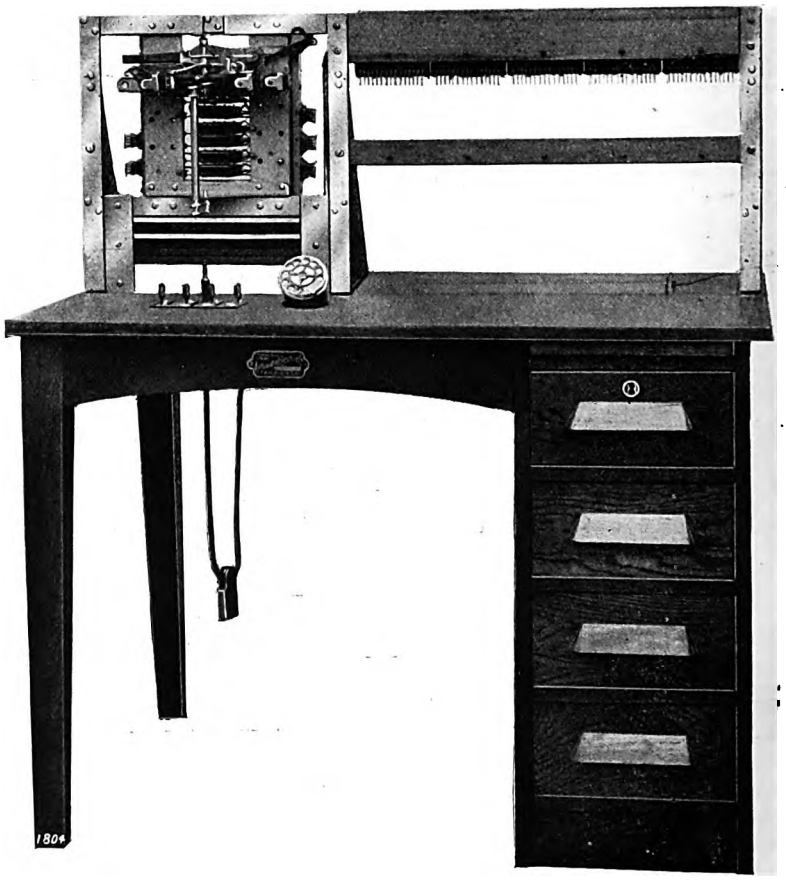
The insertion of a plug operates relay A, which breaks away the earth and slow-acting relay from the lines. The slow-acting

Digitized by Google

relay is not de-energised, as it finds an earth through the armature of relay A, and holds the caller's line until the plug is withdrawn.

Speaking power is supplied when the listening key of the hospital cord circuit is thrown.

These circuits are also used as inspectors' pairs for cable work.



37.—Testing Bench.

The — and + lines are connected to the spare pair of wires in the cable at the main distributing frame.

Observation Service.

All the pilot lamps of the various supervisory tell-tale lamps are multipled to lamps fixed at the test desk, thus giving the test clerk an idea of the general state of affairs while at the desk.

* * * *

Digitized by Google

Testing Bench.

A front view is given in 37. This bench is constructed and equipped for repairing, adjusting, and testing line switches, selectors, connectors, and repeaters.

A small line switch unit consisting of 5 line switch banks, together with a complete master switch and mounting plates for 5 line switches, are fitted in the framework above two strips of jacks.

On the underside of the top rail are five sets of connecting springs. These are wired to the jacks and switch banks so as to provide circuits similar to those which exist when each piece of apparatus is mounted in its normal position on the automatic switchboard. The rail will accommodate two selectors, two connectors, and one repeater set.

After repair or adjustment the item to be tested is fitted into its relative position on the bench, the test plug is inserted in the corresponding jack, and the calling device which is in the same circuit as the plug and keys is operated, and the working of the apparatus tested. By throwing the various keys, resistance is introduced into the calling device circuit.

The procedure is simple and effective.

Drawers are provided for storing apparatus parts and tools.

* * * *

The Manual Switchboard.

38 gives a general view of the manual switchboard, which is a two-position section fitted with a switching key, so that one operator can control both positions.

Equipment is provided for dealing with the following:

Recording, checking and passing forward outgoing trunks calls.

All incoming calls from other exchanges.

Offering trunk service to engaged subscribers.

Receiving complaints.

Furnishing information.

Calls for dead numbers.

Calls received on dead selector levels.

Supervision of coin-box stations.

Electrophone service.

Incoming and outgoing call wires.

The equipment on this board was designed to work into manual C.B. exchanges, magneto exchanges and minor trunk exchanges.

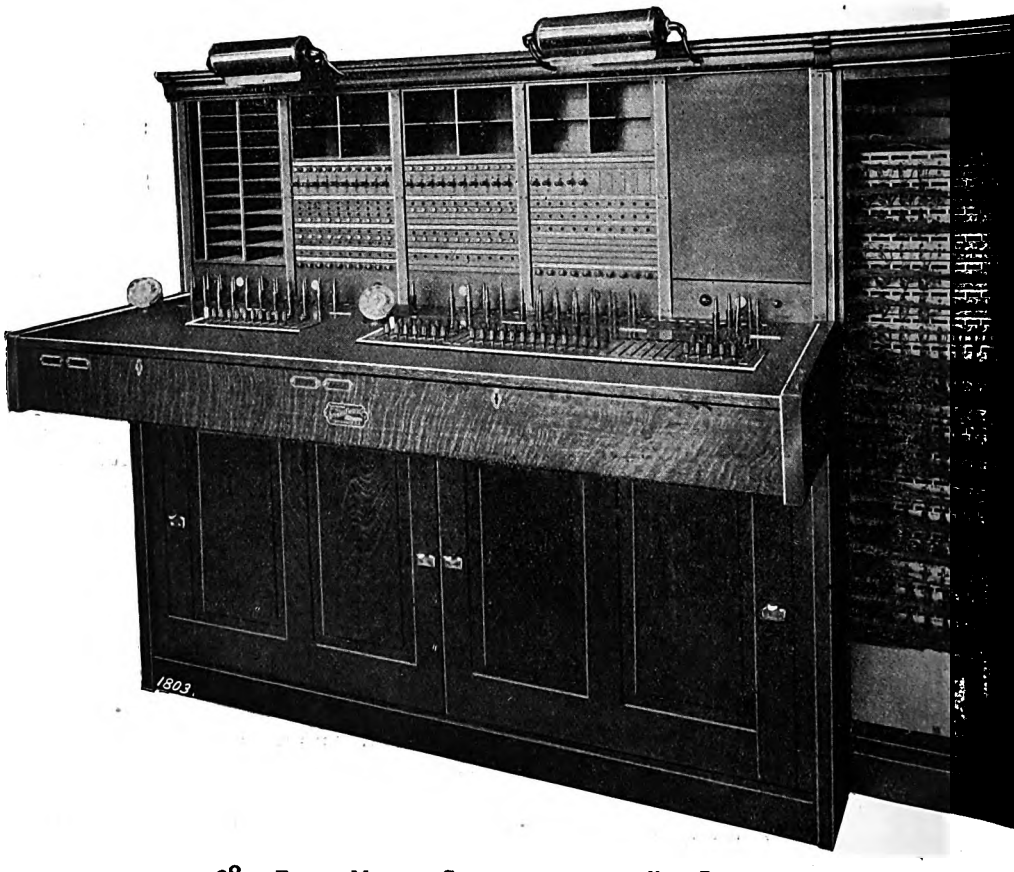
As already explained, calls originated by the subscriber for trunk service, information, or complaint, are not to be registered by the subscriber's meter. The connection is made with the manual

Digitized by Google

switchboard direct from the selector levels, and, as there is no reversal of current when the operator replies, the meter does not register.

Universal Cord Circuit (39).

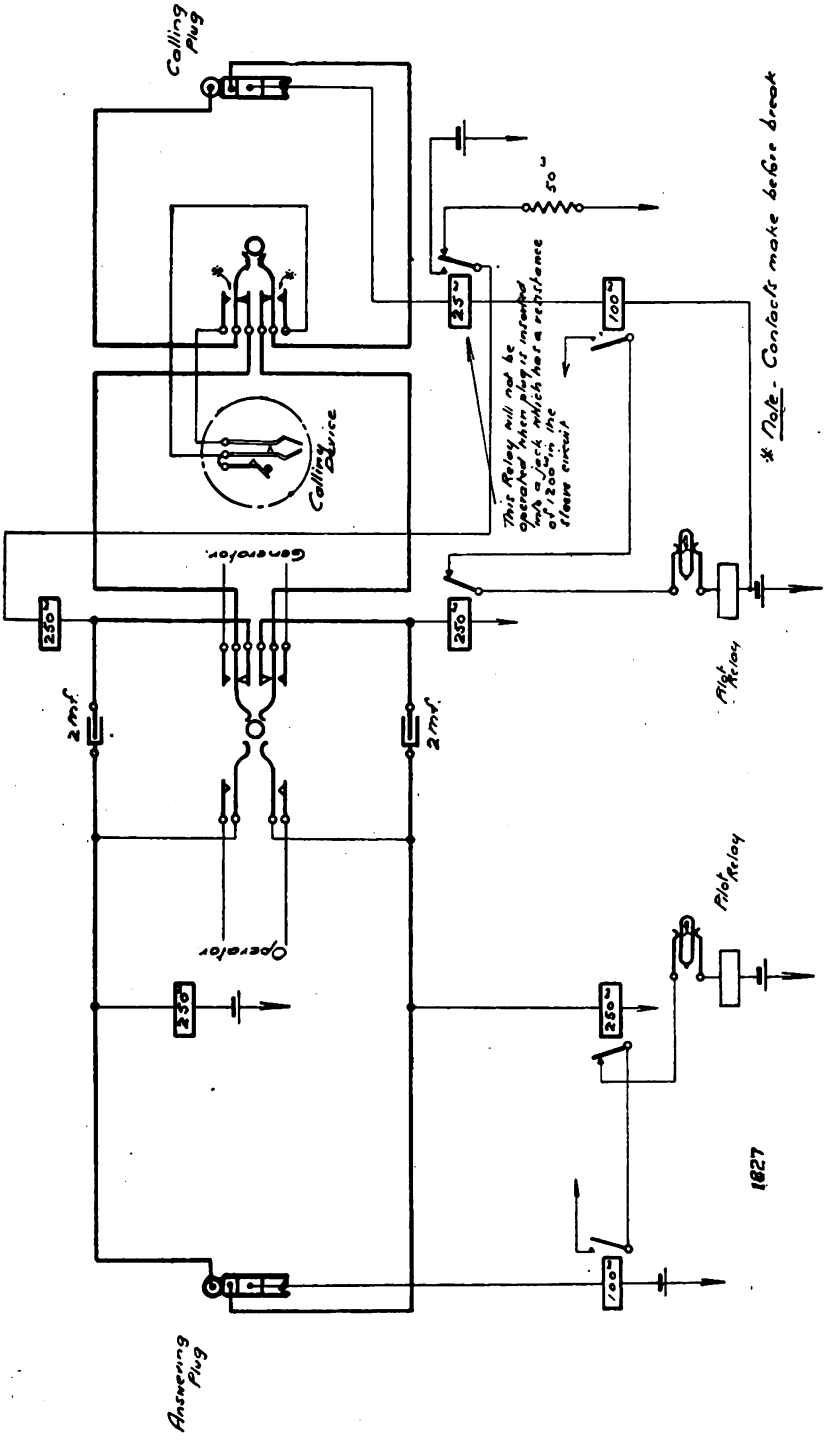
This cord circuit is designed for working with two classes of



38.—Epsom Manual Switchboard with End Panel removed.

jack-ending circuits, viz., (*a*) where speaking battery is to be supplied to the called station, and (*b*) where an earth connection to the tip is required for signalling purposes. This is the function of the 25ω relay in the sleeve circuit, which is adjusted to operate only when inserted into a jack having a sleeve resistance to earth of not more than 900ω. For example, when inserted into the jack of a coin box station (50) the 25ω relay is operated and battery connected through the 200ω retardation coil to the tip of the plug, but when inserted

Digitized by Google



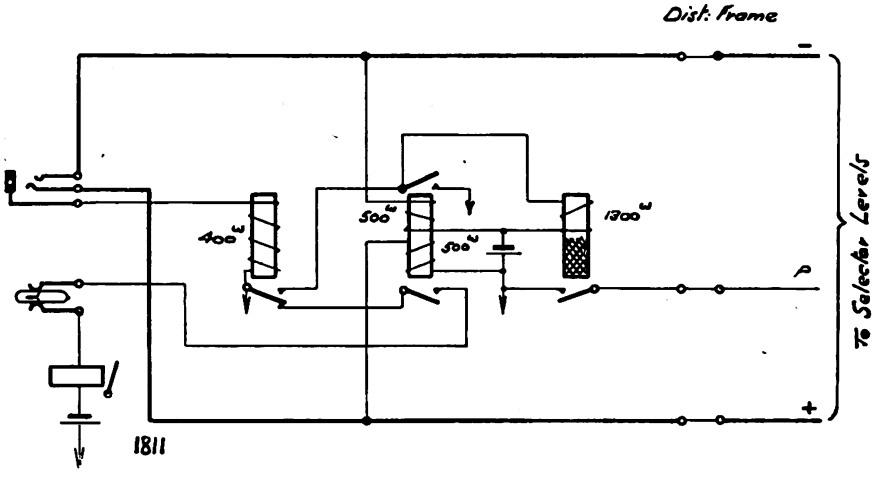
39.—Universal Cord Circuit.

Digitized by Google

into a first selector jack it is inoperative and the tip circuit remains as at normal and causes the operation of the selector line relay.

Recording and passing forward trunk calls (40).—When a subscriber originates a trunk call, he pulls round the dial from 0, lands on the 0 level of a first selector, and is connected to an idle recording circuit.

The subscriber's loop across the — and + lines operates the 500ω + 500ω line relay, which in turn operates the 1300ω slow-acting relay, whose armature earths the private bank. Observing the glow, the operator inserts the answering plug of the universal cord circuit (39) into the jack. The 400ω relay is operated from the sleeve battery, the lamp circuit is broken, and the 1300ω relay circuit is given a second path to earth, holding it so long as the plug is in the



40.—Recording Circuit.

jack, making it independent of the action of the calling subscriber, and affording a means of tracing back the call if required.

The slow-acting relay maintains the guarding earth on the private bank, should the subscriber operate his dial or rattle his receiver hook while waiting for the operator to reply.

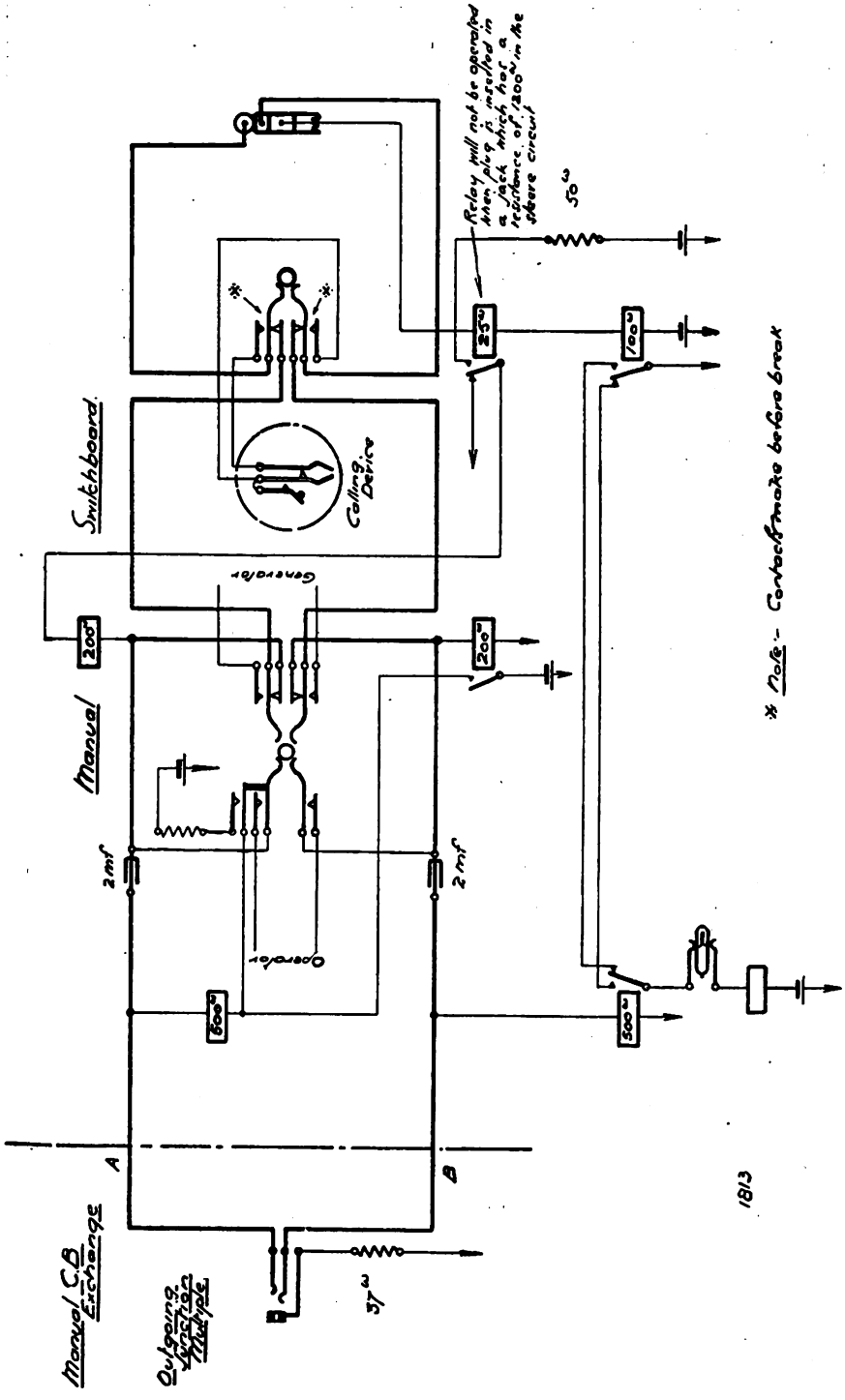
The trunk call is recorded, the number checked and passed forward to the trunk centre.

This circuit, in conjunction with the universal cord circuit, can be used for completing the connection with the coin-box stations, or the trunk centre at Leatherhead.

When the call matures, the subscriber is rung up, and being thus a "called" subscriber, the connection is made at the connector bank multiple and the meter is not operated.

One of these recording circuits will be extended over a junction line to Croydon for night service.

Digitized by Google



41.—Incoming Junction Circuit, Epsom.

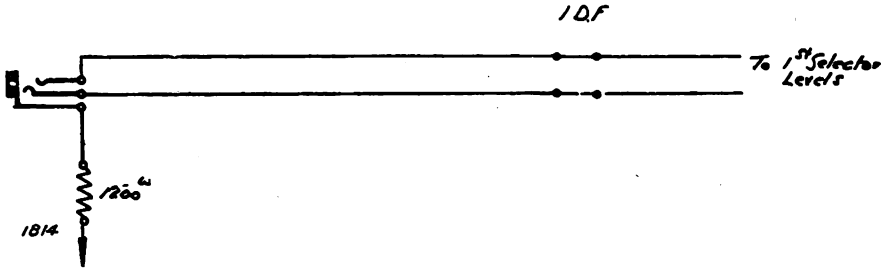
Digitized by Google

Incoming call from manual C.B. exchanges in the London area (41). —The call will be received over an incoming junction. This circuit is so arranged that the clear signal from the automatic subscriber is given direct to the originating exchange, who then clears back to the Epsom operator. On plugging into the outgoing junction multiple at the manual exchange, the battery in that cord circuit operates the 500ω relay and the lamp glows at Epsom.

The Epsom operator, on throwing her speaking key to reply, connects the battery through the speaking key contacts and the 500ω retardation coil to the "A" line, operating the supervisory relay at the manual exchange and darkening the lamp thereat.

On ascertaining the number required, she inserts the calling plug into a jack of a first selector (42).

In the sleeve circuit of the plug are two relays, 25ω and 100ω respectively. The former is inoperative when the plug is inserted into



42.—First Selector Jack Circuit.

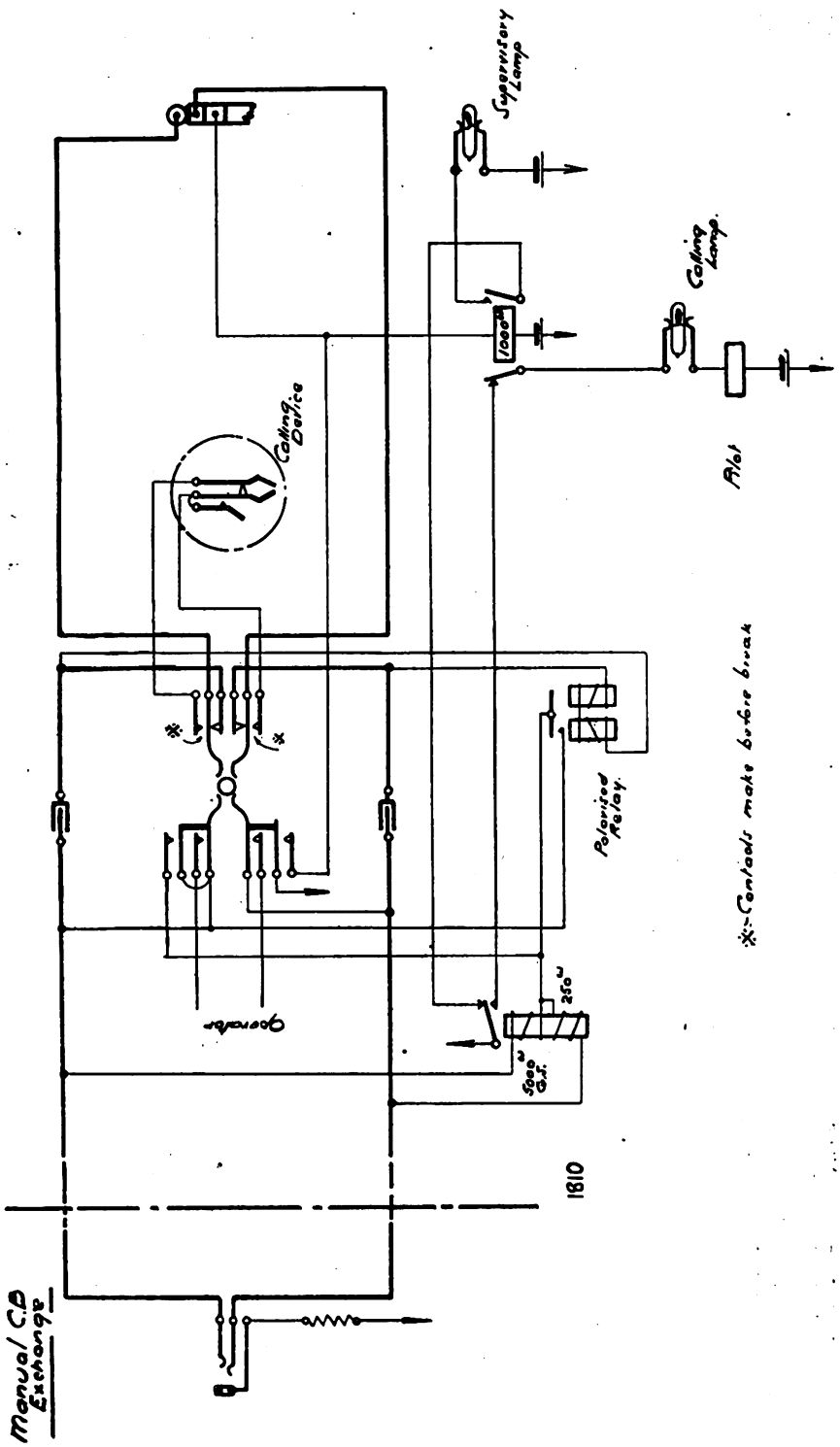
a jack having its bush connected to earth through 1200ω resistance. In this case the 100ω relay only is operated and darkens the lamp at Epsom.

The tip and ring lines are both earth connected through the 200ω retardation coil and relay respectively. The selector line relay is operated by the battery through one coil along the line through the 200ω retardation coil of the incoming junction circuit to earth. The release relay is also operated. The calling device key, which is of the make-before-break type, is thrown and the dial operated.

The selector responds and switches through the line to a connector which picks out the called subscriber's line as already described. If the circuit is engaged the calling plug is inserted into the jack of the lamp-flashing and busy-back circuit.

When the called subscriber replies the reversal of current from the connector operates the 200ω relay, and battery is applied through the armature and 500ω retardation coil to the "A" line, holding up the supervisory relay at the originating exchange.

Digitized by Google



43.—Incoming Junction Circuit Official Switch.

Digitized by Google

When the automatic subscriber clears, the connector back bridge relay is de-energised and the battery is applied through the connector line relay coil to the tip line of the plug. The 200$^{\omega}$ relay is de-energised and the supervisory lamp lights at the originating exchange.

The 500$^{\omega}$ relay is de-energised when the plug is withdrawn from the outgoing junction multiple. The clear signal is then received at Epsom.

The function of the 25$^{\omega}$ relay is seen when the incoming call is for a coin-box station as mentioned previously in connection with the universal cord circuit. For reasons which will be given later, these circuits are terminated in jacks and lamps at the manual switchboard.

It may be of interest at this stage to refer to the incoming junction cord circuit (43) which is provided for the manual switchboard for the official switch, where there are no special arrangements.

It is the Automatic Electric Co.'s practice to use a polarised relay where the junctions are to be connected to automatic subscribers only. The manual exchange operator on plugging into the outgoing junction operates the 250$^{\omega}$ + 5000$^{\omega}$ relay which lights the lamp.

The operator, on throwing the listening key, short-circuits the 5000$^{\omega}$ coil, and thus darkens the supervisory lamp at the manual, exchange. The calling plug, when inserted into the selector jack bridges the polarised relay across the lines, but this relay is not operated until the called automatic subscriber replies and reverses the current. The armature of the polarised relay then short-circuits the 5000$^{\omega}$ coil of the calling relay and the supervisory lamp at the manual exchange remains darkened.

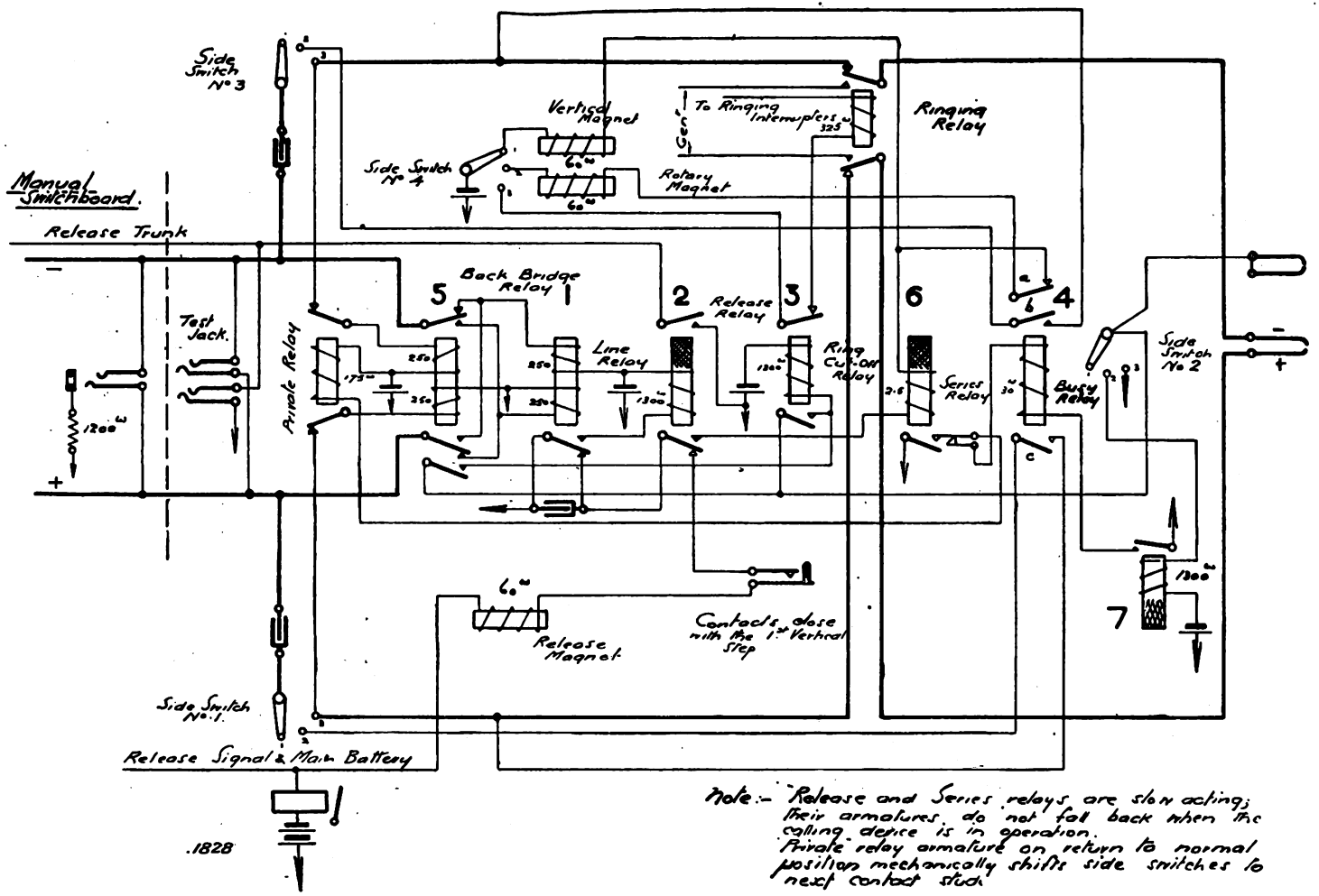
When the called automatic subscriber hangs up, his connector current is reversed, the polarised relay armature falls back and the supervisory lamp at the manual exchange glows.

Incoming calls from trunk (long distance) exchanges.—In accordance with Post Office practice, facilities are required whereby a trunk call may be offered to a subscriber who is engaged locally.

For this purpose five special OFFERING CONNECTOR CIRCUITS (44) have been provided, *i. e.* one to each switchboard unit so wired as to ignore the busy test, and enable the operator to tap an engaged circuit.

The operator, on receiving a demand over an incoming junction (41) for a subscriber for trunk service, will insert the plug into a jack outgoing to a first selector, as described for an incoming call from a manual exchange in the London area. If the busy tone is received on the completion of the signalling she will withdraw the plug and insert it into that jack of the OFFERING CONNECTOR CIRCUIT which is connected to the particular 100 group in which the subscriber's

Digitized by Google


Side Switch No 3
Vertical Magnet
To Ringing Interrupter
Ringing Relay
Side Switch No 4
Rotary Magnet
Manual Switchboard.
Release Trunk
Back Bridge Relay
Test Jack.
Private Relay
Line Relay
Release Relay
Ring Cut-Off Relay
Series Relay
Busy Relay
Side Switch No 2
Release Magnet
Contacts close with the 1st Vertical Step
Side Switch No 1
Release Signal & Main Battery
.1828
Note:- Release and Series relays are slow acting; their armatures do not fall back when the calling device is in operation.
Private relay armature on return to normal position mechanically shifts side switches to next contact stud.

44.—Offering Connector Circuit.

Digitized by Google

line is located, and operate the calling device for the tens and units digits only.

The vertical and rotary magnets respond as described for the ordinary connector and the side switches pass to contact No. 2, relay 7 is energised, and when the series relay falls back on the conclusion of the unit signals the private magnet circuit is retained *viâ* the make contacts of the series relay and through the busy relay and the armature of the slow acting relay No. 7, which will now be in contact with the earthed bank of the called subscriber who is engaged in local conversation. When the busy relay is energised armature "*a*" breaks the rotary magnet circuit so that it cannot be operated further, while "*b*" and "*c*" armatures respectively connect the — and + lines of the wipers to contacts No. 2 of the side switches 1 and 3, and so through the condensers to the operator, who, breaking into the conversation, offers the trunk call. If accepted both subscribers are requested to clear. When this is done the earth is removed from the private wiper and the busy and private relays are de-energised. The side switches move to No. 3 contact, the called subscriber is made busy to other subscribers, and battery is applied to the ringing relay and the subscriber rung up. Immediately he replies the reversal of current operates the 200$^{\omega}$ relay (41) and darkens the lamp at the originating exchange. Slow-acting relay 7 is inserted into the circuit in order to maintain the earth on the busy relay and private magnet circuit while the release of the ordinary connector is being effected. Without this slow-acting relay in circuit the private magnet might fall back immediately and shift the side switches to contact No. 3, earthing the private and holding up the B.C.O. coil of the subscriber's line switch and a first selector.

Information and complaint service (45).—These circuits are key ending. The subscriber pulls round the dial from figure 8 and lands on the eighth level of the first selectors and picks up an idle line to the switchboard. The subscriber's loop operates the 250$^{\omega}$ + 250$^{\omega}$ relay and the white lamp glows. The operator throws the key and notifies her presence on the line, giving the required information or recording the complaint.

This operation energises the 1000$^{\omega}$ relay, which is locked *viâ* its own armature, and that of the 250$^{\omega}$ + 250$^{\omega}$ relay, the white lamp darkens and the red lamp glows. The third contact on the 1000$^{\omega}$ relay places an earth on the release wire, thus holding the selector switching relay and the B.C.O. coil of the line switch independent of the action of the calling subscriber.

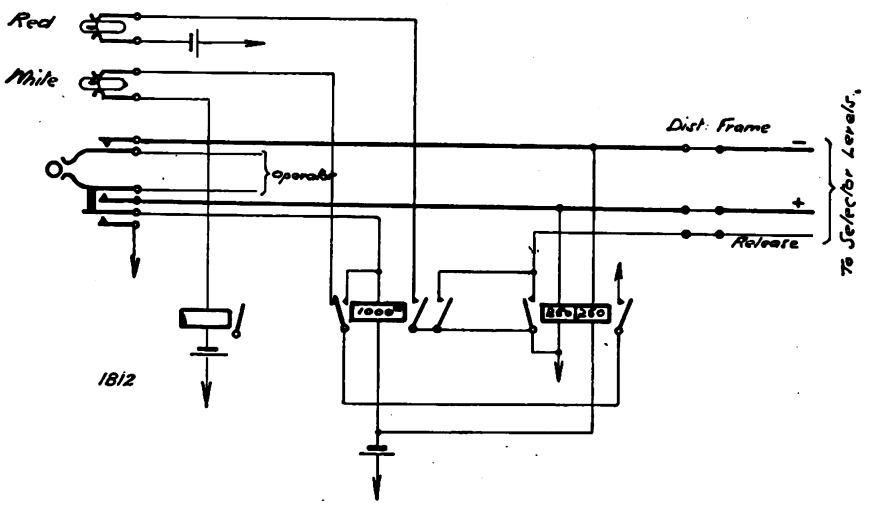
The advantage of this is obvious, as the operator by keeping the key thrown can hold the circuit while the test clerk traces back the call to its origin, if such a course be necessary.

The red lamp glows until the calling subscriber releases the

Digitized by Google

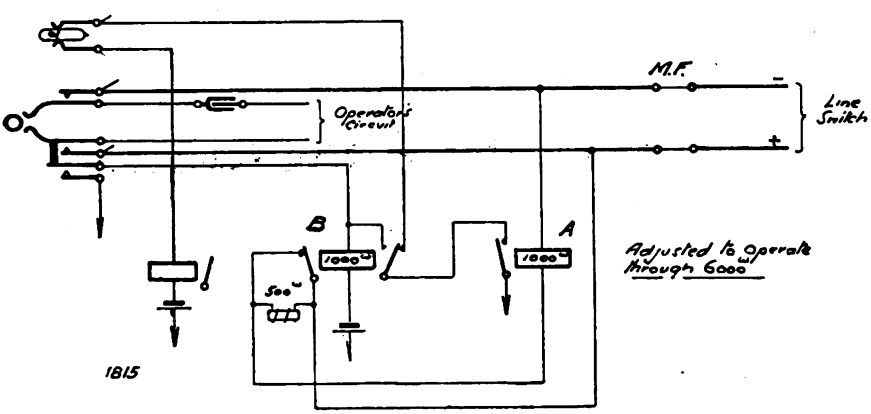
circuit, giving a signal to the operator should she restore the key in order to attend to other calls before obtaining and furnishing the information required.

Dead number circuits (46).—These are also key-ending circuits



45.—Information and Complaint Circuit.

and wired to the distributing frame, where they can be jumpered to any dead circuit which may have been given up, suspended, or changed over to another number.



46.—Dead Number Circuit.

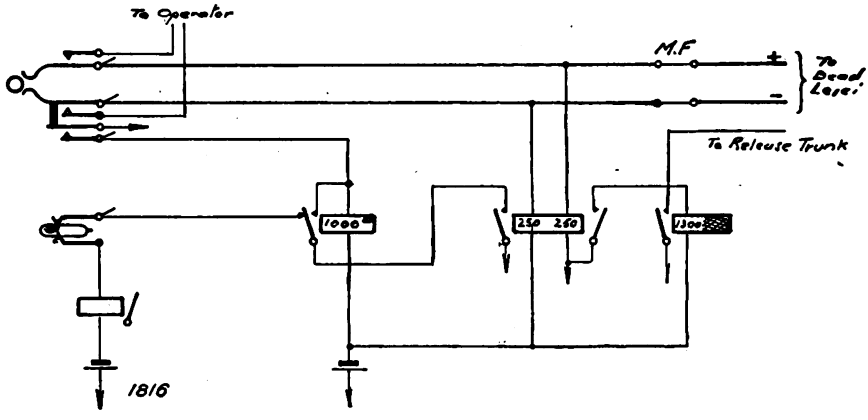
On being picked up by a calling line, relay A is operated and the lamp glows. The operator throws the key and informs the caller of the condition of the circuit which has been dialled.

Dead level circuits (47).—These circuits are connected to dead

Digitized by Google

levels, so that if the subscriber calls for, say, No. 7, 10, 11, 12, 13, 14 or 18 he will land on a level which has no live circuits.

His loop will operate the 250ω + 250ω relay and the lamp will

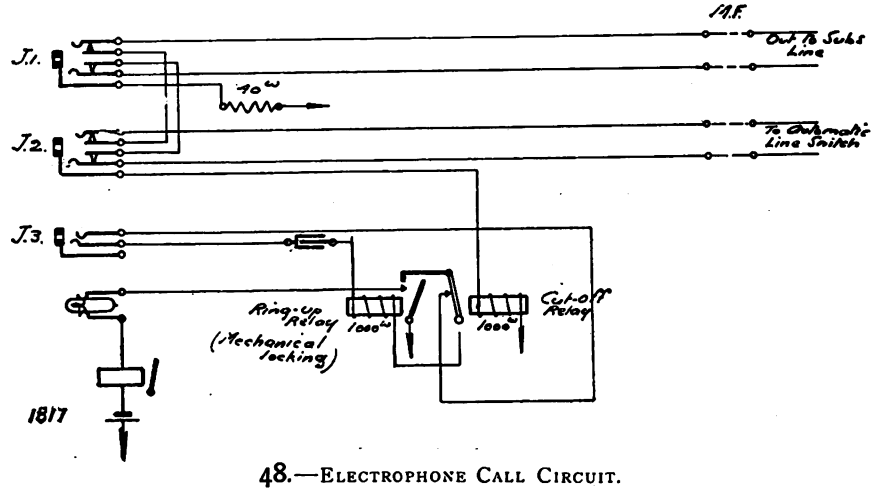


47.—Dead Level Circuit.

glow. The operator will reply and advise him that a wrong number has been dialled.

Electrophone Service (48).

The lines of subscribers entitled to electrophone service are taken through break-jacks as indicated.



48.—Electrophone Call Circuit.

The usual service answering circuits and distribution circuits with jacks for music, listening and distribution are also provided.

Briefly, the method of supplying music is as follows: Junction lines between Epsom and Central, and Central and the Electrophone

Digitized by Google

Exchange, are appropriated and plugged through at the Central Exchange by means of straight through plugs so that the music is supplied to Epsom over junction lines free from all supervisory apparatus. At Epsom this junction is plugged through to a distribution circuit, which consists of three distribution jack-ending circuits (each having supervisory bridges for receiving the clear from the subscriber), one music jack and one listening jack.

The Epsom subscriber dials 0, asks for the Electrophone service and restores. When all is ready the operator plugs into the subscriber's break-jack *J1*, rings subscriber and requests him to switch over to his Electrophone receiver. Simple straight-through plugs are then inserted into *J1* and a distribution jack.

J2 and *J3* are also connected by means of straight-through plugs, switching the subscriber's line switch through to a "ring-up and cut-off" relay. The subscriber receiving music is thus freed from interruption and all calls for him are received on this relay.

The operator will attend to these calls and advise the caller that the called subscriber is receiving music. If the call is urgent, she can withdraw the music plug from *J1* and offer the call. If accepted, *J1* and *J2* will be connected by a universal cord circuit.

Coin-Box Stations.

A theoretical diagram of an ordinary coin-box station of the Strowger type is given in 49.

To originate a call the subscriber lifts the receiver, which causes the line switch to plunge into a first selector line.

During the operation of the calling device the receiver and transmitter are shunted out of circuit, the path for the common battery being from the − line across the receiver hook, upper contact, shunt and interrupter springs, polarised magnet, which is not operated, and back *viâ* the + line.

When the called subscriber replies the battery circuit is reversed and the polarised magnet operated, the tongue engages with the trigger and pulls the three springs into contact, short-circuiting the transmitter and placing a 30ω shunt across the receiver.

The calling subscriber can hear the reply, but is unable to speak until the coin is deposited. This releases the trigger and breaks away the short circuit and the 30ω shunt.

No deposit of coin is necessary, however, if the coin-box station calls up for information or complaint, as will be seen by referring back to 45. There is no reversal of current on the circuit to pull over the armature of the polarised relay.

In view, however, of the fact that the fees differ for local and junction calls, and that users of public coin-box stations are required

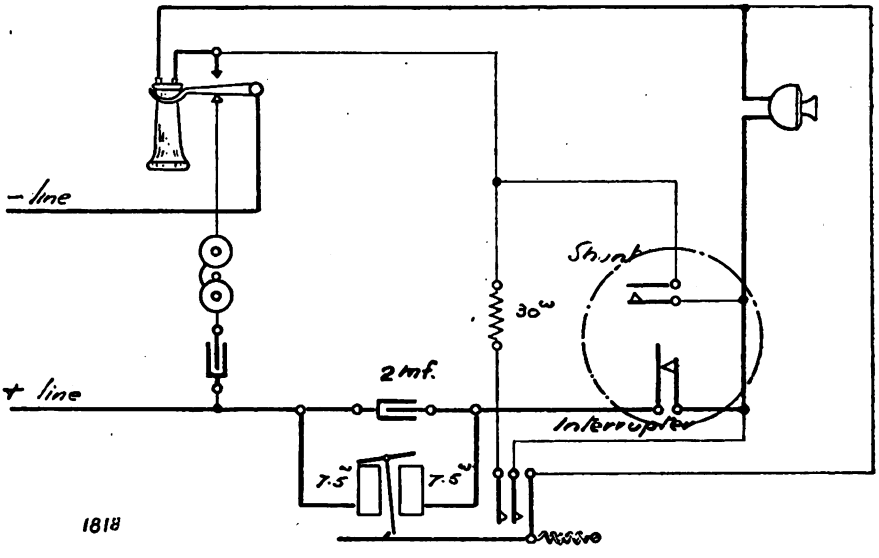
Digitized by Google

to pay a fee for incoming as well as for outgoing calls, it has been arranged that the operator shall supervise the insertion of the coins.

Coin boxes of the Ericsson type are used in connection with ordinary C.B. telephone sets.

Public coin-box circuits are terminated at the switchboard as ordinary C.B. circuits, and all calls, to and from, will be dealt with by the operator.

Private coin-box circuits are joined up as shown in 50. The arrangement is such that the subscriber can be called up by an automatic subscriber night or day, but all originated calls will be received and supervised by an operator. The caller's loop operates

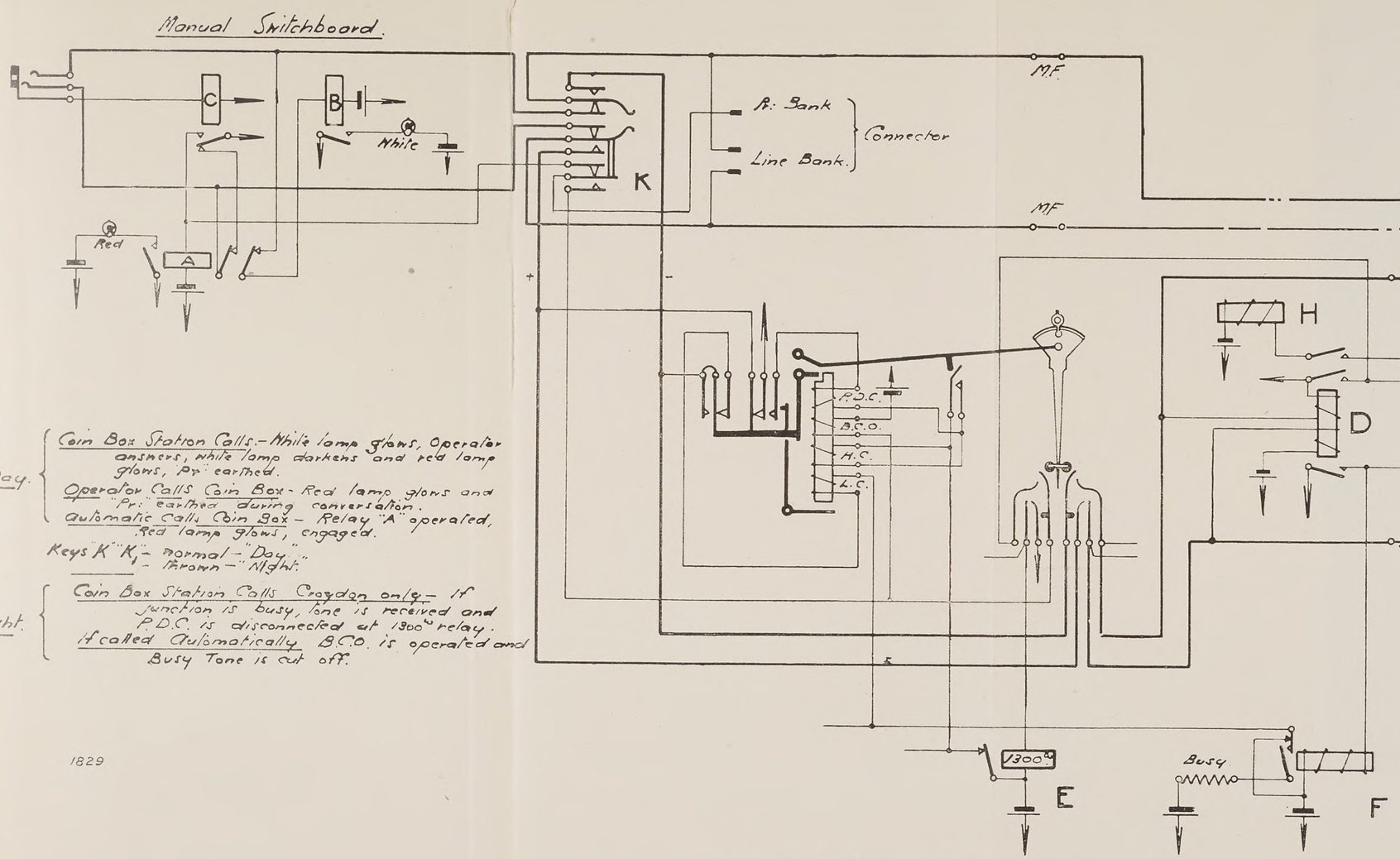


49.—Coin Box Telephone.

relay B and the white lamp glows. The insertion of the answering plug of the universal cord circuit pulls up C, A is operated, the red lamp glows; B is cut out, the white lamp darkens, and the private bank contact is earthed at C armature, making the circuit busy against other calls. The operator then plugs the calling plug into a first selector jack and dials the required number. When a reply is received she supervises the insertion of the coins.

Calls for private coin-box stations.—An automatic subscriber on dialing, say, 585, will cause a connector to tap the bank contacts of this circuit, and if disengaged will earth the private bank. Relay A will be operated, cutting out B and breaking the earth away from the *Ring* or B line. The red lamp will also glow and give an engaged signal at the manual switchboard.

Digitized by Google



Day. { Coin Box Station Calls.- White lamp glows, Operator answers, white lamp darkens and red lamp glows, Pr earthed.
Operator Calls Coin Box - Red lamp glows and Pr earthed during conversation.
Automatic Calls Coin Box - Relay "A" operated, Red lamp glows, engaged.

Keys K "K1 - normal - "Day."
- thrown - "Night."

Night. { Coin Box Station Calls Croydon only.- If junction is busy, tone is received and P.D.C. is disconnected at 1300 relay.
If called Automatically B.C.O. is operated and Busy Tone is cut off.

1829

50.—Coin Box Circuit with Night Arrangements.

Digitized by Google

to p
arra
(
ordi
]
ordi.
by t

arra
aut
rec

rel
in
th
an
th
ca
W

di
th
A
fr
er

18

Digitized by Google

Night working.—At night-time the Croydon operator will supervise the deposit of coins.

The key K of each coin-box station will be thrown, cutting out the manual switchboard apparatus, and switching their respective circuits through to special line switches fitted inside the manual switchboard. The particular line switch when operated will connect the coin-box station to Croydon over the special junction reserved for coin-box station originated calls. K *1* will also be thrown.

When one of these stations has engaged the Croydon Junction, relays D, E, G, H, and F will be operated; the last-named relay will apply the busy tone to the line coil of the remaining lines, so that should a second coin-box station originate a call during this period it will receive the busy tone, and as E is energised and its armature pulled up the P.D. coil will not operate. But calls can be received by him whether the Croydon Junction is engaged or not inasmuch as his *Pr* bank is not earthed.

The other circuits and arrangements on the board do not call for special reference.

Strowger Transmission System.

The speaking circuit is shown theoretically in 51.

The transmission system employed includes condensers and relays acting as impeding coils associated with a common battery.

Comparison tests have been made, with results as shown in the following schedule:

Comparison of 46-volt System (using Strowger Electro-magnetic Receiver Set) with the Standard W.E. Co. System.

Resistance in subscriber's loop. Ohms.	46-volt system better (+) or worse (−) than W.E. Co.'s 22-volt system with equal resistance in subscriber's loop by ... miles of standard cable.	
	Transmission.	Reception.
0	− 4½	+ 1
100	− ½	+ 1
200	+ 1	+ 1
300	+ 2	+ 1
400	+ 4	+ 1
500	+ 5	+ 1½
600	+ 6½	+ 2

* * * *

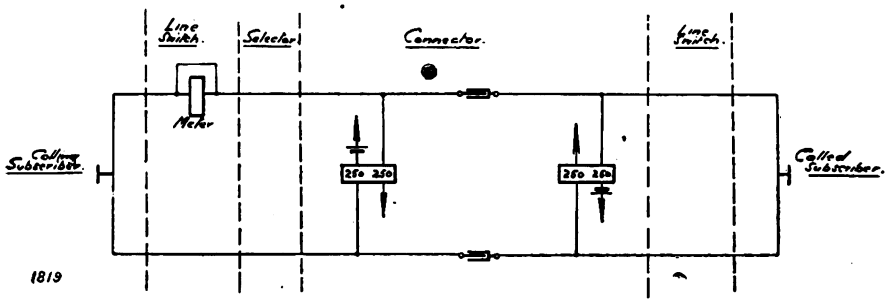
This description has dealt principally with the arrangements at Epsom and the official switch, and does not pretend to cover all the

Digitized by Google

special features of automatic telephony which obtain in actual practice abroad, such as discriminating tone service, back checking for toll calls, traffic metering, secondary line switches, frequency selectors for party lines, power feeding to private branch exchanges, etc.

To the engineer a mere statement is inconclusive without the proof of the diagram, and no apology is therefore felt to be necessary for loading this article with such matter. In fact, it may be the means of satisfying, for a time at any rate, that which has been a long-felt want of many of the readers of this JOURNAL.

Most of the circuit arrangements have been designed by the Automatic Electric Co. of Chicago.



51.—SPEAKING CIRCUIT.

It is probable that the connector circuit may be slightly modified as regards the "busy" in order to give the busy flash signal to the originating exchange.

Meters will also be inserted at certain points of the automatic exchange to ascertain the amount of traffic passing over the various parts of the equipment.

In conclusion, adapting the words of "the preacher," although of making many diagrams there is no end, yet it is hoped that "much study thereof" may not prove to be a "weariness of the flesh," for it is a certainty that in the progress of telephony and telegraphy, as each new diagram is designed and issued, there will ever be "more to follow."

Digitized by Google

EPSOM TELEPHONE EXCHANGE: CONVERSION TO AUTOMATIC SWITCHING.

By R. W. CALLENDER.

THE first public automatic telephone exchange in the British Isles was opened at Epsom, Surrey, on May 18th, 1912.

The equipment, which is of the "Strowger" type, is for five hundred lines, and was installed by the Automatic Electric Company of Chicago. A fortnight only has elapsed since the opening, but the experience gained in this interval has been sufficient to leave no doubt that, like many a forerunner in mechanical appliances designed for improving the precision and economy previously attained by fallible and expensive human operations, it has come to stay.

Many of the subscribers have already given profuse expression to their whole-hearted appreciation of the new telephone service, whilst the only exception brought under notice locally has been that of one gentleman who complained that the finger-holes in the calling device were too small for his fingers.

It is possibly not too much to say that no one thing has ever been constructed or created that pleased everybody; and it will be a sufficient tribute to the ingenuity and resource of our American cousins to testify that their bulletins of the Strowger automatic telephone system which reached us from time to time prior to its installation in the "Old Country" were not a bit too fulsome or exaggerated.

With the rapid growth of the telephonic demand experienced in this country during the last few years, and the more recent assimilation of the late National Telephone Company's subscribers into Post Office Exchanges, exchange transfers have now become quite ordinary items in the daily life of telephone engineers. But there were circumstances connected with this one, chiefly on account of the types of exchanges concerned, which rendered it more than ordinarily interesting, and this must be the writer's excuse for thus offering his observations.

Hitherto the subscriber had had little or nothing to contribute towards the actual transfer operation; this time, however, he or she were to be important assistants, and the issue was dependent to an appreciable extent upon his or her intelligent co-operation. Many of the subscribers were "Ex-National Company," who had but recently been subjected to the inconvenience of duplicate sets of apparatus pending their transfer to the Post Office C.B.S. Exchange, and it was considered inadvisable to again subject them to similar inconvenience.

Digitized by Google

Accordingly, modifications of the then existing C.B.S. operator's cords were designed locally, which allowed either the old C.B.S. or the new automatic telephones to work to the old C.B.S. Exchange prior to the transfer, and also permitted the recovery of the C.B.S. instruments and batteries and their replacement by the automatic instrument by one visit on the part of the fitter. Further, the signalling "earths" associated with the "A" lines at all C.B.S. telephone stations were connected to the automatic instruments through 6 point 2-position switches, which were all fixed with the same end uppermost, in order that the subscribers could be requested by postal communication to push the switches down at a given time for the transfer, and thereafter to make their calls in accordance with printed instructions supplied to them. The reversal of the switches was to remove the "earths" from the "A" lines and thus leave the circuits in the proper condition for C.B. working.

The date ultimately fixed for the transfer was May 18th, at 3 p.m., and one wondered during the few minutes immediately preceding the critical moment how far, and with what degree of accuracy, the subscribers would respond to the request made to them. The banks of selector and connector spindles were also contemplated with a good deal of interest, as it was realised that in a few moments many of them would be jumping into life, ratchetting upward, rotating and dropping down again at the individual wills of the calling subscribers. The engineering operations inside the exchange to effect the transfer were not in any way unusual. Two main frames were involved, the C.B.S. equipment was disconnected by withdrawing the heat coils from the old one, and the new automatic equipment joined up by withdrawing wooden wedges from between the line springs and the heat coils on the new one.

These frames were on different floors, and it was essential that all the old heat coils should be drawn before any of the new ones were joined up; otherwise the "loops" formed by the "earth" on each A and B line at the C.B.S. Exchange ends would have plunged the line switches of any circuits joined up beforehand at the automatic end. Nevertheless, the whole operation was completed in the space of two minutes.

An officer was posted at the selectors to attempt for a short period to count the number of spindles operating together, but the large number so operating combined with their rapidity of movement and the neutral colour of the mechanism made this an impossible task.

An examination of the master switches, however, showed that none of them were "hunting" for selector trunks, thus proving that all calls which were being properly made were "going through" without being delayed by an insufficient number of selectors; and

Digitized by Google

this, despite the fact that each master switch was controlling one hundred line switches.

Immediately after 3.2 p.m. operators and test clerks began calling the subscribers and requesting them to make experimental calls to certain numbers which had been allotted to telephones fixed in various positions in the switch and test rooms, and the subscribers were then informed that all local calls would be "free" up till 5 p.m. on that day.

Nearly all the subscribers reversed their switches as they had been requested, but many of them failed to use the calling device correctly, dialling numbers which brought them to the "dead level" and "dead number" lamps on the manual board and then trying to call again without the necessary operation of replacing the receiver for a new start. Others appeared to hesitate for a long time on the second or third digit of the number they were calling and thus "held up" selectors for an unduly long period.

Yet others assumed that inner London and remote London Exchanges were proper for the "long distance" call, which of course brought them to the "information" operator; and it was said that one subscriber complained because he could get no attention although he had been *shouting* oh! for a long time. No doubt he was duly instructed to use the cypher (0) on the calling device.

All this kept the operators very busy instructing subscribers in the use of the dial, and on this account only it was as late as 8 p.m. before all those subscribers who were available to answer calls had been obtained.

Two circuits developed line faults during the transfer afternoon, and twenty-four subscribers could not be obtained by reason of business premises being closed, or the subscribers being away from their homes for the time being; but the satisfactory condition of these last mentioned circuits was ascertained by testing for "condenser"; and early on the following Monday morning the whole of the 340 subscribers had been spoken with.

All the junction circuits were proved by 3.30 p.m. on the Saturday. It was necessary to hold each of the outgoing junctions "engaged" after it had been proved, whilst the remainder were being proved, to prevent them being mechanically picked up again for test by the selector.

Great credit is due to the operating staff for the efficient and willing way in which their new operating movements were carried out. Especially is this so in view of the fact that their opportunities for practice beforehand had been very limited, by reason of the manual board being in the hands of the wiremen right up till the morning of the transfer day.

Much interest in the transfer was shown by the "Press," there

Digitized by Google

being many reporters present to whom demonstrations in automatic working were given.

One of these gentlemen immediately after witnessing the heat-coil operation at 3 o'clock went into the Exchange call office cabinet, and dialling the office of his paper, there and then sent his "copy" *by Automatic Telephone* for insertion in that afternoon's edition.

The transfer was watched by Mr. E. J. Ivison, of the Engineer-in-Chief's Office, Mr. Edmunds of the Controller's Office, and also by Mr. Gomersall, the acting Superintending Engineer of the South Metropolitan District, who was of course responsibly interested.

In addition to the modifications of the operators' cord circuits, already referred to as necessary for working the automatic instruments on the C.B.S. Exchange, temporary internal modifications had to be made in the following cases: Intercommunication sets, counter communication sets, private branch exchanges, main sets with simple extensions, and plug and socket wiring, and in some of the cases permanent modifications were necessary to adapt them for automatic working.

A HISTORY OF AUTOMATIC TELEPHONY.

By R. Lawson.

In the following historical account of the development of automatic telephony, it will be seen that I have practically restricted myself to one system, viz. the Strowger. This appears desirable for two reasons, first, because it will form a better introduction to Mr. Bailey's article on the modern system now working at Epsom; and secondly, because considerations of space preclude an adequate study of the Lorimer system, which is so absolutely different as to require separate treatment.

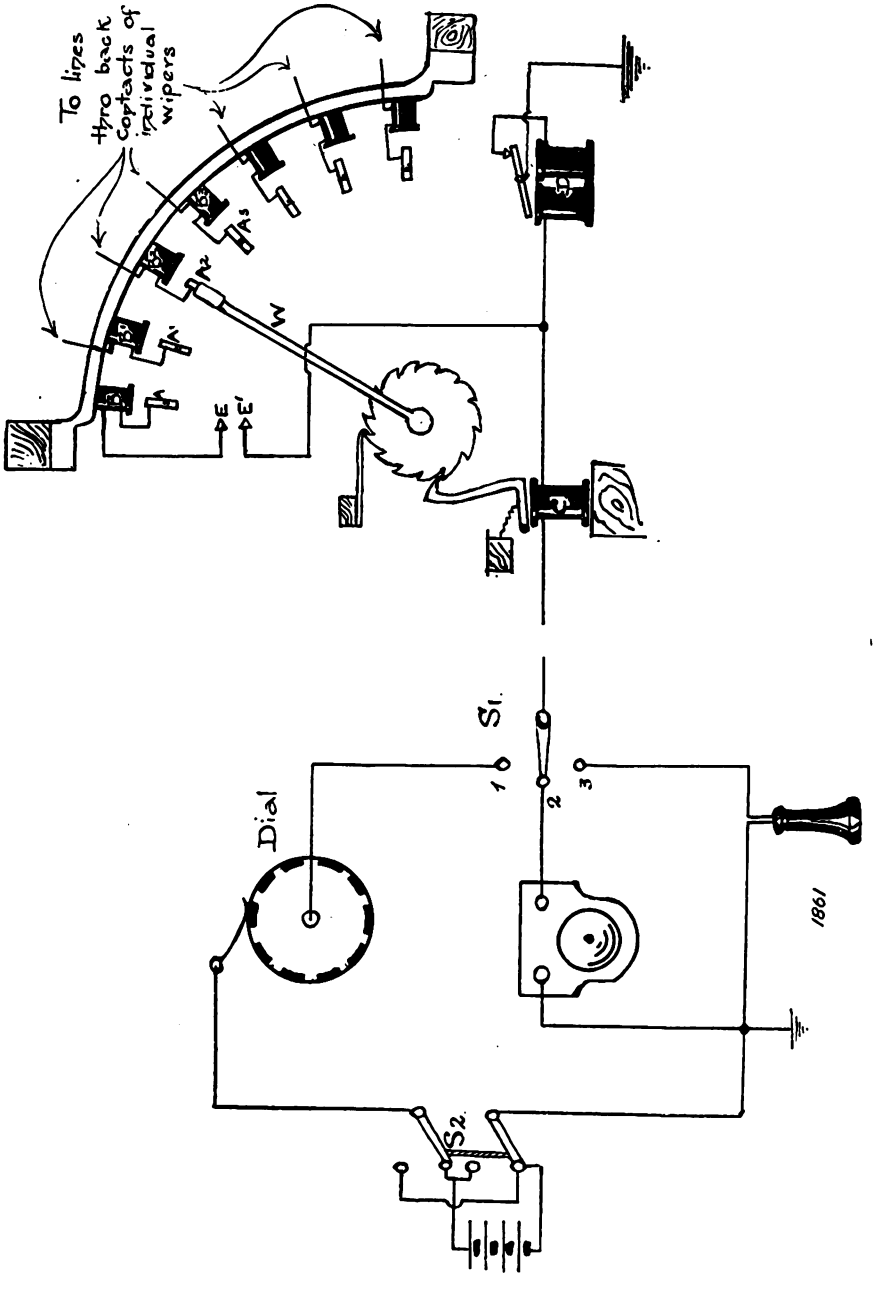
Before the development of the Strowger system some useful spade work had been done by McTighe and the brothers Connolly, and the first patent in automatics was taken out by these gentlemen on December 9th, 1879. 1 is as close a reproduction of the figure in their patent as I can make it consistent with clearness.

A statement of the proposals contained in the specification is as follows: The sub-station set had three circuits controlled by a three-position switch S_1, these circuits being for signalling, selecting, and talking. The apparatus at the sub-station included a battery, a commutator S_2, a polarised bell, and a combined receiver and transmitter.

The apparatus at central was to include a number of wipers (w) mounted on a common shaft, each wiper bearing on its end a sliding

Digitized by Google

clutch, which was adapted to move over and to come in contact with hook-bearing bars A, A^1, A^2, etc. Arranged in the form of a



I.—First Patent in Automatic Telephony—Connolly and McTighe.

quadrant of a circle round the axis of the wipers were the private magnets, B, B^1, B^2, etc., and these magnets could, in certain con-

Digitized by Google

ditions, withdraw the bars immediately in front of them, at the same time maintaining contact with the wipers by means of the clutch-hook attachment if the wiper happened to be over the particular bar withdrawn. A bar so withdrawn, however, was out of the path of any other wiper which might travel past it while in this "engaged" position.

One private magnet was provided for each bar, one wiper for each subscriber's line, and each bar had as many hooks as there were wipers. A driving magnet (C) and a selector relay (D) were fitted in addition. The driving magnet moves the wipers by the ratchet and pawl arrangement shown, and there is one driving magnet provided for each wiper. In the idle position each subscriber's line at Central was to be joined to its own private magnet through the contacts E, E^1 and the wiper, but this circuit is disconnected on the first motion of the wiper.

It is the function of the selector relay to disconnect the central earth after selection has been made. The selector relay and the private magnets were polarised and set neutral, so that they remained in whatever position placed until moved by current of proper polarity.

Normally the switch S_1 is in the central position, and both ends of the line are earthed. Switch S_2 also occupies the position shown. To select a number, S_1 is turned to its first position, and the dial is then rotated a suitable distance so that it interrupts the current from the local battery the correct number of times. This advances the wiper by the operation of the driving magnet, but the selector relay and the private magnets are not operated because the polarity is wrong. When the dial motion ceases the switch S_2 is reversed, thereby actuating both selector relay D and whichever private magnet the wiper stands opposite. The bar in front of the private magnet operated is then withdrawn, carrying with it the movable clutch on the wiper end, and at the same time the bell of the required party commences to ring. To talk, the switches at both ends of the circuit are placed in position 3.

On completion of the conversation the called subscriber puts his switch back to the middle position, but the caller must go back to position 1, and reverses his pole-changing switch, so as to restore the contact bar and selector relay.

The interest of this patent is purely historical, as it apparently could not have worked as described in the specification. There were developments of the same proposal in a patent of August 29th, 1881, but it was quite impossible to work a system economically or efficiently in which comparatively considerable mechanical power had to be obtained by the action of simple electro-magnets joined directly in the line circuit. The friction of the moving parts, in the

Digitized by Google

earlier switches at least, was very great, and it became necessary either to use relays in the line circuit, with magnets in local circuits, or alternatively to have a permanent power drive with the magnets doing light directive work only.

Power drive was employed by Connolly in a flat switch, which he developed in 1883. In this switch two sets of bars—horizontal and vertical—crossed one another at right angles in a manner very similar to the Umschalter switch. Up and down each vertical bar a slider was constantly driven, while across the horizontal bars a second slider attempted to move, but was held off by a rack. It was the function of the magnet in the subscriber's line circuit to release the horizontal slider step by step until the correct vertical bar had been attained. The collision and contact of the two sliders afforded the connection between the two subscribers.

Continuous power drive is still retained in the Lorimer system to-day, but the Strowger system, as operated by the Automatic Electric Company, and also by Messrs. Siemens, utilises relay and local circuit drive for most of its movements.

Strowger's first application for an automatic patent was filed on March 12th, 1889, although at the time his ideas do not appear to have been very clear. When they did take shape, however, in 1890 he utilised a cylindrical form of bank, there being ten rows of contacts, each row containing 100 terminals, and the whole circumference being used to contain the terminals. The shaft, which was placed axially in this cylinder, was capable of a vertical and rotary motion, the vertical motion being controlled by one magnet with a single step action, while the rotary motion was controlled by two magnets, one of which moved the shaft round in jumps of ten, while the other moved it round in single steps. The system required five wires from the sub-station, three being used for signalling, one for releasing, and the fifth for talking. Many of the essential features of the present service were contained in this proposal, *e. g.* the arrangement of the contacts in rows on a curved surface, vertical motion followed by rotary, and complete release in one action; but the system could not give privacy; and, in selecting a number, the calling subscriber actually made contact with the lines of all intermediate numbers before getting on to the required line.

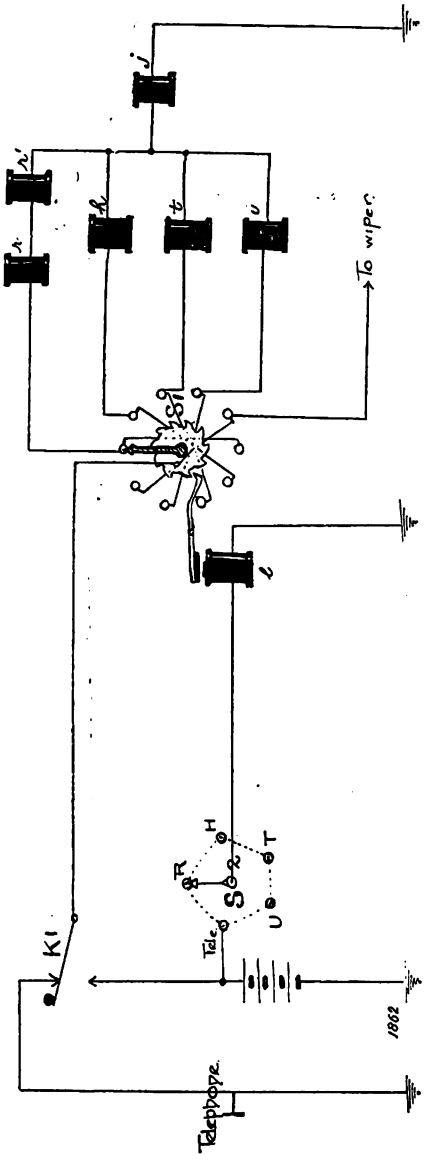
The difficulties of satisfactorily constructing ten rows of terminals all absolutely parallel and the friction introduced by any departure from truth were so great, that in the next development the design was radically altered to that known as the "flat disc."

In this form there were ten concentric rings, each containing 100 contact studs fixed in an ebonite table, and having a vertical shaft capable of rotation about the centre of the circles.

Digitized by Google

The shaft bore a horizontal arm upon which the wiper proper could slide.

Each ring on the disc represented a certain hundred and each



2.—Skeleton Circuits of Flat Disc Board. First Commercial Application of Automatics.

individual contact a definite unit in the hundred. The " hundreds " selection was made by the movement of the wiper along the arm under the impulses of current from the subscriber, these impulses attracting an armature which operated a bell-crank lever. The " tens " and " units " selections were made by ordinary step-by-step

Digitized by Google

rotation, but the "tens" selection operated in jumps as in the older design. To overcome friction every movement due to the vertical or rotary magnets was accompanied by a slight lifting or jumping action, which raised the wiper off the disc, this jumping action being controlled by a "jumping magnet" in series with the impulse magnets.

2 shows the skeleton connections of the arrangement patented in November, 1892. In this switch the line wires were reduced to two, the upper line being taken direct through key K_1 to the wiper on switch S_1 and thence to the magnets r, r', h, t, u and the jumping magnet j to earth, while the lower line passed through the dial switch S_2 and the relay l to earth.

Normally the apparatus is as shown, with the finger on the dial switch (S_2) resting on the "release" stud. The studs R, H, T, U and TELE are all joined to the sub-station battery, but in moving from one stud to the next the battery is disconnected. To call, the dial switch is rotated to H, thereby sending one impulse through l, which turns S_1 round one notch and brings its contact arm on to the hundreds stud at Central. Key K_1 is then depressed the required number of times, operating relays h and j in series, and thus propelling the wiper along the horizontal shaft. After signalling the hundreds digit the dial switch S_2 is rotated to T, an impulse of current through l follows, and S_1 is stepped round to make contact with the tens stud. The tens digit is then signalled. To signal the units digits the dial switch is moved to U and key K_1 depressed. After completing the signal the dial switch is turned to "Telephone" and key K_1 depressed to send ringing current out on the called line. When conversation ceases the dial switch is rotated to R again, the release magnets are operated, and everything returns to normal. The switch S_1 carried ten studs, but these were made up of two groups of five multipled.

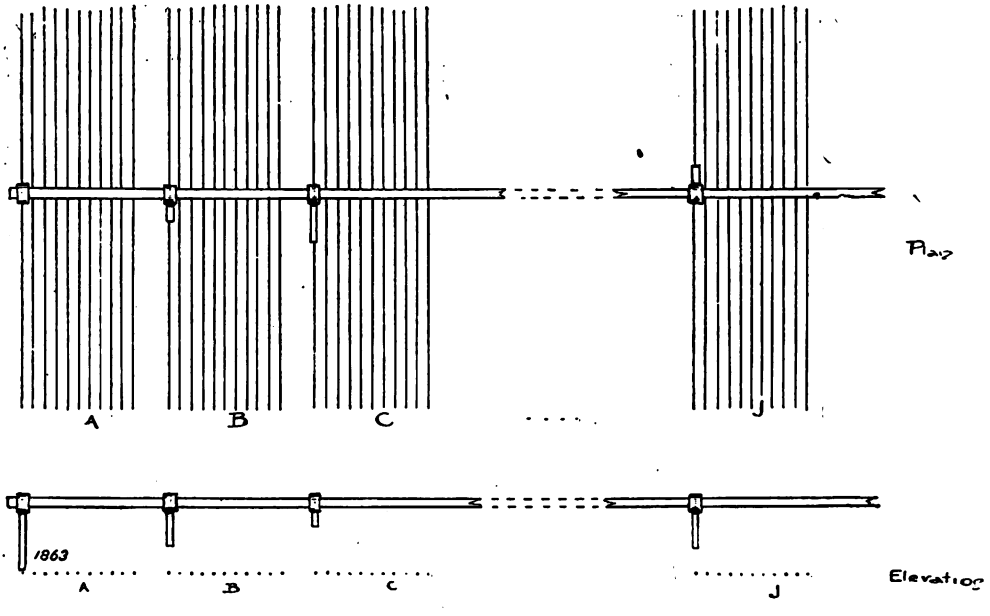
In this switch we can recognise the genesis of the vertical or impulse wire (the upper line in the sketch), the rotary or directing wire (the lower line), and the side switch S_1, and it was this type which was first installed in La Porte, Ind., U.S.A., and opened to the public on November 3rd, 1892.

An attempt was made at this time to revert to the flat rectilinear arrangement of contacts, and the brothers Erickson applied for a patent in March, 1893, wherein the signals from the sub-station first drove the wiper along horizontally, and then, upon the operation of a pole-changer, drove up the vertical rows. The arrangement was soon dropped, however, in favour of the piano-wire board installed at La Porte 1894.

This was an arrangement in which the subscribers' lines were led on to parallel wires arranged in groups of ten, as shown at A, B, C, etc., in 3. Immediately over these wires were placed the selecting

Digitized by Google

machines, each consisting of a shaft capable of lateral and rotary motion, and bearing wipers which were electrically and mechanically attached to it. The number of wipers borne by the shafts was equal to the number of groups of lines, the distance between them was equal to the width of a group of wires, and they were staggered round the shaft at equal angular intervals. The lengths of the piano wires were determined by the number of selecting machines working, and each shaft was capable of motion laterally a distance equal to the extreme width of a group and of rotation round the complete circle. Obviously, therefore, it was possible to select any number



3.—Piano Wire Board. Arrangement of Wires and Shaft.

joined to the wires by first moving the shaft until its wipers came over the desired level in the groups, and then rotating the shaft until the proper wiper made contact with the group containing the wanted subscriber. Common battery was used for selection.

The objections to the system were that it utilised gearing to effect both motions of the shaft, that it was not private, that its capacity was limited and that release was not automatic.

An endeavour was made to increase the board to 1000-line capacity, and circuits were designed which overcame most of the objections just mentioned, but they were never introduced in practice, and the flat field was definitely abandoned at this time to revert to Strowger's original plan of circular arrays of contacts with an axial shaft.

Digitized by Google

In 1895 the first board having the present form of bank was introduced, each row in the banks consisting of ten brass stampings separated by layers of electrose. The type of axial shaft was also the forerunner of those now in use although rather more complicated. Three buttons were used for selecting at the sub-station set, the hundreds and units buttons earthing the rotary line and the tens the vertical line. Privacy was guaranteed by the use of a relay which opened the caller's circuit when passing over an engaged line.

The outstanding advantages of the new line of construction were (1) large capacity with small over-all dimensions, (2) vertical motion against gravity requiring only one spring restoration, and (3) private service. The gravest objection to the first design was the fact that there were four magnets in the talking circuit. The board was installed at La Porte in June, 1895 (what a long-suffering community must inhabit La Porte!), and in August, 1895, a 200-line board of the same kind was installed at Michigan City. The electrose separation between the banks having given some trouble owing to swelling and warping, plaster-of-paris was used in the next board of this type, which was introduced at Rochester, U.S.A., in November, 1895.

As the number of operations required of the subscriber when selecting had hitherto been most inconvenient and slow, the dial sender was now introduced to undertake the function. Patent for an efficient dial was applied for in August, 1896, the mechanism in this dial sender being capable of earthing either line as required to operate the necessary relays at central. The dial sender was first introduced in June, 1896, on a private installation, and automatic release by the restoration of the switch hook was provided concurrently.

The limitations of one switch unit being so narrow the use of primary and secondary switches was now attempted. The first selectors had ten vertical steps and one rotary, *i. e.* they had only one junction to each group of connectors, and although such an arrangement works at very low efficiency it was introduced at Augusta in March, 1897.

The next stage was to give automatic selection over more than one junction per group. This was first obtained by interposing a "nought" in the subscribers' numbers between the hundreds and tens groups, so that, *e. g.*, subscriber 123 now became subscriber 1023. Then signalling the thousand digit selected the correct hundreds group, the pulling of nought gave ten impulses of current to drive the wipers over the junction contacts, and the mechanism of the switch operated to cut off the current as soon as an idle junction was struck. The caller was then put through to a connector to operate the tens and units digits as in the older apparatus.

It is interesting to notice that 1898 saw the first introduction of

Digitized by Google

automatic working into Europe, a 400-line board being installed at Amsterdam in June of that year, while a somewhat similar board was installed in Berlin in May, 1899.

In 1900 the first public example of an automatic junction selecting installation was equipped at New Bedford, Mass. This system was very much on the lines of present-day practice, using interrupted drive for rotary selection of an idle junction. The engaged test in this installation was provided by negative battery. The talking circuit was not very good, however, as there were eight 30$^{\omega}$ relays in series in the line when through, and although each relay was shunted with a 150$^{\omega}$ non-inductive resistance the efficiency was still low.

In the Fall River system, installed in 1901, the circuits were very similar to those at New Bedford but with the following differences. Instead of shunting the relays to avoid their impedance in the talking circuit, a thin copper tube was slipped over their cores and the coils wound on that. The engaged test also was provided by earth on the private banks instead of negative battery.

In the next important installation—Chicago, December, 1902—measured service was catered for. The metering device relied upon the fact that a definite number of impulses were sent over the subscriber's rotary line before the conclusion of a conversation (in a 10,000 line system this would be five-four for the digits and one for release). The counting wheel was driven by a pawl attached to the meter magnet against the action of a spring, and at each successive step it was locked by a click. When it had made five forward motions the meter registered one. If the called subscriber did not reply, however, the release impulse would fail, and the dropping of the axial shaft as the selector restored, knocked out the click and allowed the counter to slip back without registration. In this Chicago installation was provided the private test as now ordinarily given, and it is interesting to note that a P.B.X. system was also provided giving automatic selection of the first non-busy line in the group.

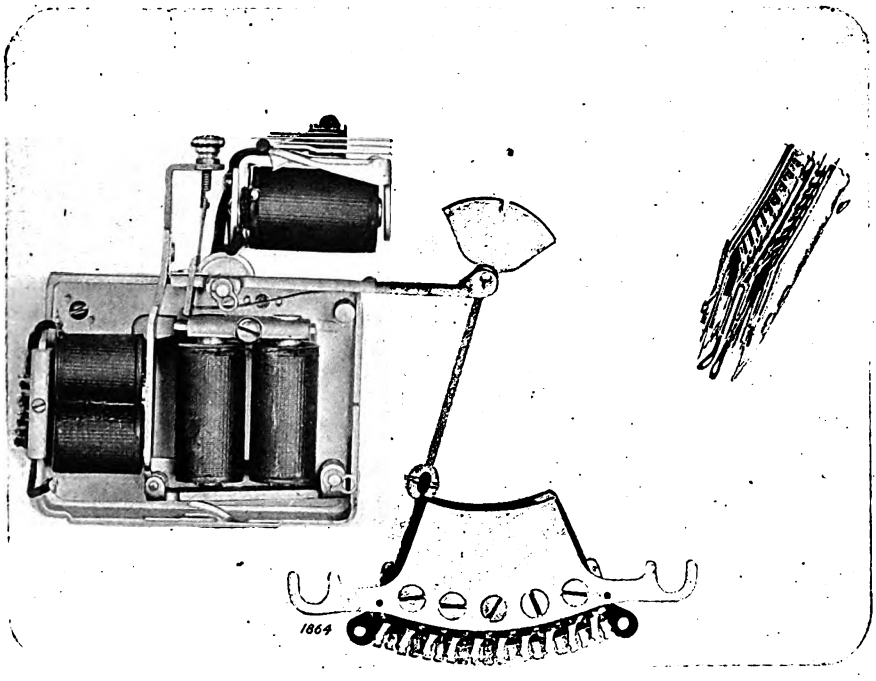
To increase the efficiency of the talking circuit the next improvement in design substituted the series relays by bridging relays. These relays were wound to 500$^{\omega}$ each, and after their selecting functions had been performed they were put across the line, the side switch severing the series connection as the line goes through to the next switch. The objection to this bridging system was that a relatively heavy current was required to operate six 500$^{\omega}$ relays in parallel when clearing, so that release was not in all cases efficiently performed.

"Trunk release" was first introduced at Los Angeles in July, 1904, and this system, with some modifications, is the present standard. In this arrangement release is effected serially through the switches

Digitized by Google

over the release or private wire and the circuits of the release trunk are purely local. At Los Angeles also the first commercial introduction of intercommunication between automatic and manual systems was effected.

The apparatus by this time was being manufactured on a commercial scale and in accordance with well-established electrical and mechanical theory. Some of the special features have already been described by me in another place.* Each switch unit was now made of interchangeable parts and consisted of two main divisions,



4.—Old Pattern Line Switch.

the banks and the switch proper. Since very little trouble is to be anticipated with the banks these are permanently wired when set up, but the wiring of the switch proper (which includes shaft, wipers, relays and magnets) is carried to lugs capable of dropping into suitably placed grips on the section frame. A faulty unit can thereby be lifted out bodily and replaced without delay. This interchangeability, however, involves great care in manufacture and intelligent handling subsequently.

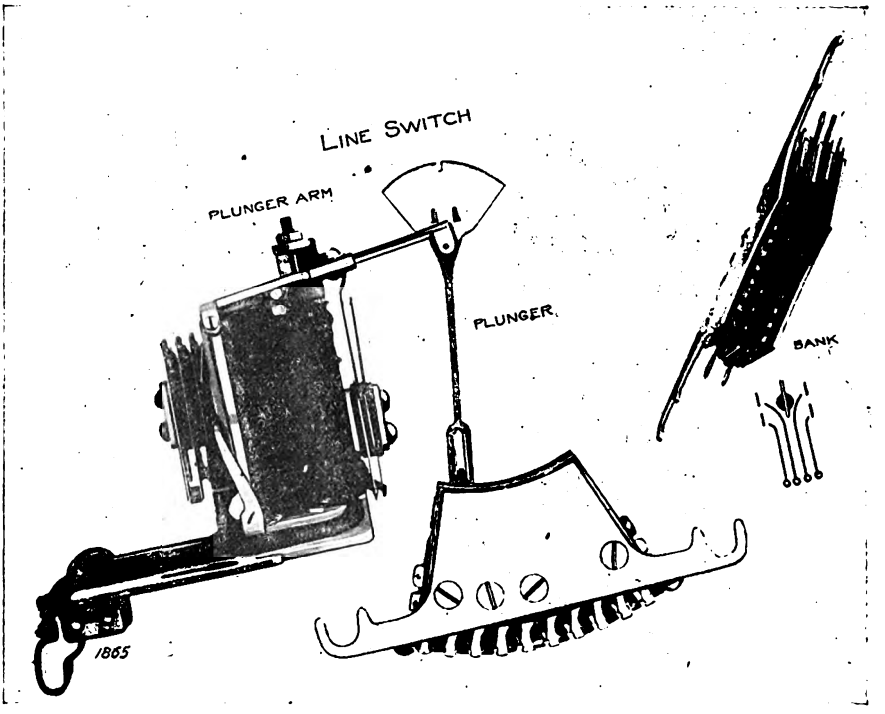
Attention was at the same time given to the determination of a standard floor plan for automatic plant, the general arrangement

* 'Automatic Telephony,' R. Lawson.

Digitized by Google

being to associate first selectors with the connectors serving the same lines, and to group the second selectors in an orderly way to correspond with the connectors which they serve. Except that the line switch now supplants the first selector in its relation with the connector this arrangement still obtains. The method of rotating the multiple wiring between the switches has been described in the paper already referred to.

The heavy expense involved in the provision of one first selector



5.—New Pattern Line Switch.

for each subscriber's line was still a great drawback to the system, but this drawback was largely discounted by the introduction of the line switch in 1904. The line switch has been described many times, and photos of the two forms which have been introduced by the Automatic Electric Company are given in 4 and 5. The line switch enables considerable economies to be made in Central Office plant owing to the fact that the percentage use of this plant is always low. This percentage idea was very early appreciated by Gallender in the development of his system (1893), but the Strowger apparatus does not seem to have availed itself of the principle for quite a considerable time. Siemens' pre-selector exercises the same functions

Digitized by Google

6.—Diagram of Subscribers' Station—Old Form.

Digitized by Google

as the Keith line switch, although its circuits are very different and its development came much later.

Party-line working had been attempted in the early stages of automatic development, but it had not been pursued with any vigour. An efficient system was first introduced at Miamisburg in June, 1905. Harmonic ringing was employed to select the various subscribers on the line, and in order that this might be done without the exercise of special intelligence on the part of the calling subscriber, each party line had four multipled terminations in the connectors, one in each of four separate groups. The ringing frequency on each of these groups was different, so that having got into the right group by ordinary selection correct ringing frequency was assured.

C.B. working was first installed at South Bend, Ind., in May, 1905, the sub-station set being Stromberg-Carlson type with $14^{\omega}/25^{\omega}$ induction coil. The connector in a C.B. system, of course, requires to feed current round the loop for talking, whereas the selecting signals on the systems devised up to this time had been along the individual lines to earth. The change of feed is performed by an additional relay on the connector which operates on the reply of the called subscriber, and when conversation commences ordinary modified Stone conditions obtain.

Repeater service for long lines was introduced at Los Angeles in 1906, and an improved modification was equipped at Columbus in 1907. By this means the service is accelerated, and the speaking efficiency is increased as the circuit of a "repeated" line has its batteries localised as in ordinary junction service.

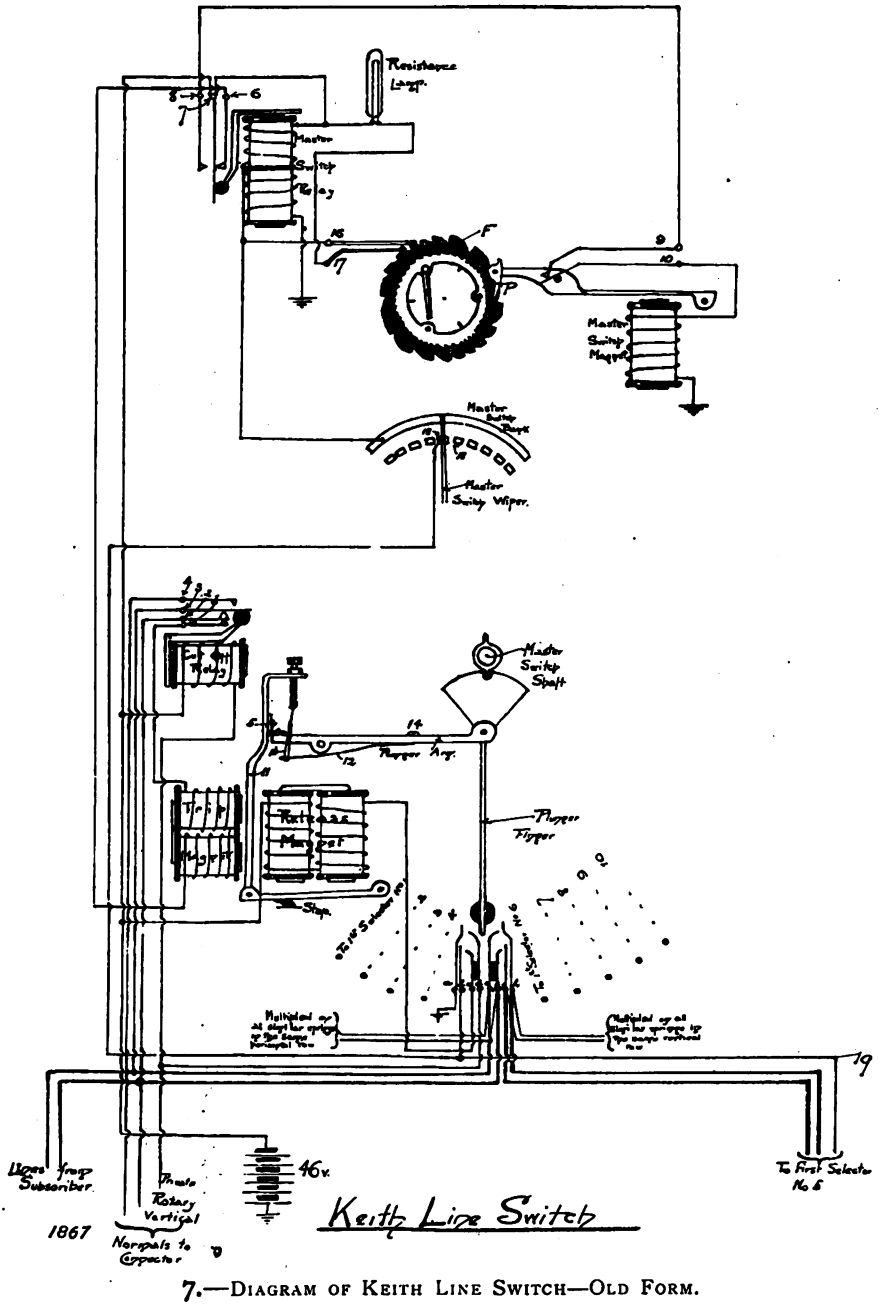
To simplify the sub-station apparatus the system in which earth signalling was used (the three-wire system) has now been superseded by one in which simple disconnections are utilised to operate the central apparatus. This system (the two-wire system) was first introduced in 1909 by E. A. Mellinger, Esq., now of the Automatic Telephone Manufacturing Company, Liverpool (English patent 1298/1910), and the economies effected in the sub-station plant can be appreciated by comparing 6, representing the old sub-station set and the set shown in Mr. Bailey's paper. The introduction of the soft iron receiver in the sub-station set has nothing to do with automatic development as such, of course, but if the claims made for it can be justified its apparent advantages are many.

The introduction of the two-wire system also cheapened the line switch, as a comparison of 4 and 5 will suggest. The circuits of the old pattern line switch are shown in 7, and they should be contrasted with those in Mr. Bailey's paper. The crank drive used on the old line switch has now been substituted by a spring drive with solenoid return in the new pattern.

In the latest form of selector and connector, the three banks of

Digitized by Google

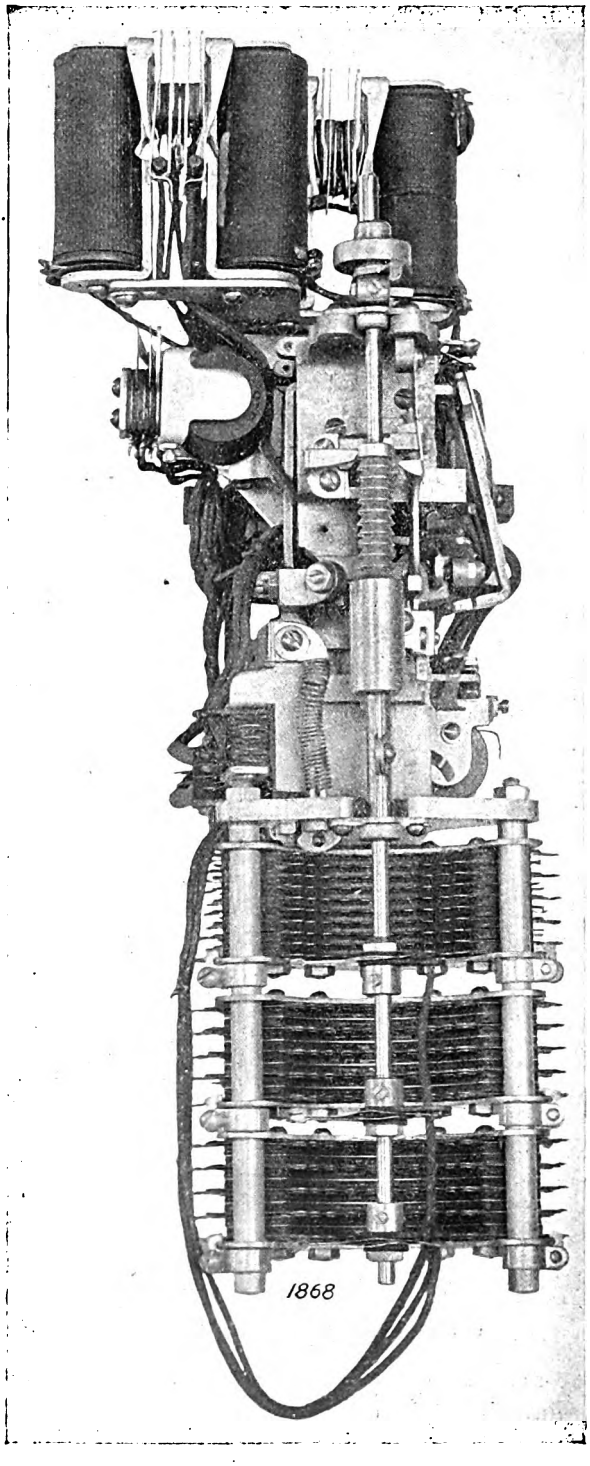
the old switch have been substituted by two in the new—compare



7.—Diagram of Keith Line Switch—Old Form.

8 with that shown in Mr. Bailey's article—and the side switch has been eliminated from the selector in favour of additional

Digitized by Google



8. — Common Battery Connector—Old Form.

Digitized by Google

relays. The other alterations broadly consist of substituting quick and slow acting relays in series for selection, instead of the two ordinary relays which formerly existed—one in each side of the line —between central battery and the sub-station.

It is difficult to forecast the direction of future advance. The possibilities of utilising the line switch or pre-selector for auxiliary service have already been appreciated, as, for example, in the traffic distributor, and further development on this line may be anticipated. The possibility of using automatic telephony to solve the difficulty of night attendance in small country offices is also under consideration, and arrangements to meet this requirement will probably soon be devised.

FACTS OR OPINIONS?

By E. A. LAIDLAW, M.I.E.E.

THE appearance of a number of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL devoted specially to automatic telephony is an indication of the growing interest which telephone engineers are taking in the coming changes in telephone exchange systems. All around questions and opinions such as the following are heard: "Do you believe in automatics?" "Do you think the full automatic will ever come?" "The semi-automatic is the thing!" "What do you think about the automatic?" "I do not think you can do away with the operator."

"Automatic" is discussed as generally and as heatedly as a coming election, and in a great many cases with the same absence of careful thought. Views are expressed and opinions are sought just as if "automatic" was something to be "believed in," some new doctrine which required a certain amount of faith for its acceptance.

In the early days, when inventors were laying the foundations of their systems and apparatus, this attitude was justifiable; in fact it is due to the unconquerable enthusiasm and almost heroic faith of these inventors that we have reached the position in which we are to-day; they "believed in" their ideals, and their belief is now being justified. But admirable as this enthusiasm may be in the inventor, it is out of place in the engineer. An engineer should approach the subject in a different way. His duty is to array all the available facts, from these facts to draw his conclusions, and to do this in an unbiased and logical way so that his conclusions will admit of no more contradiction than a mathematical proposition, granted always of course that his facts are real facts.

Digitized by Google

This opens a rather delicate question. An engineer well known to many readers of this JOURNAL remarked to the author some time ago that there seemed to be something contagious about automatic telephony; as soon as a man became connected with it in any way his morals at once deteriorated.

Undoubtedly there have been incorrect statements made both by those who "believe in" automatics and by those who do not, and they have been made simply because the subject has not been viewed from an engineering standpoint. An engineer has no use for mis-statements or opinions; he must deal with facts.

Now are real facts available? A year or two ago the real facts were very few, but to-day there are sufficient automatic exchanges in operation to enable an engineer to obtain data enough from which to draw his conclusions without possibility of contradiction. These exchanges are under the control and observation of government authorities or other administrations, entirely independent of manufacturing concerns. The facts are available, and they are real facts. Further, all the facts are available, those which count against the automatic as well as those which count for it. There is now, therefore, no excuse for expressing opinions based on generalisations or for taking cover behind charges of mis-statement.

In an article of this nature it is, of course, possible to touch on only a few of the points on which information is now available, but it will be well to put on record the facts with regard to some features of automatic and semi-automatic working on which general doubt now exists.

First of all as to the service which can be rendered with an automatic equipment.

FACT 1: *The service is of a very high standard of accuracy.* In 12,000 observations made on two automatic exchanges, and among all classes of subscribers, only ten calls went astray, of which five were due to failures of the mechanism, and the remaining five were indecisive.

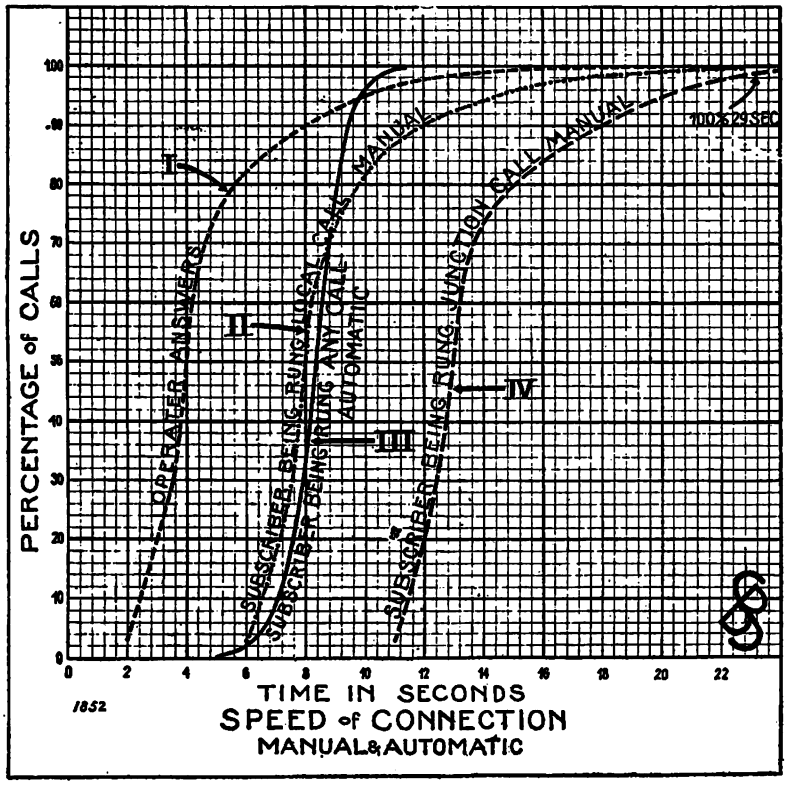
FACT 2: *The service is rapid.* The curves in I show the time required to complete a connection on an automatic exchange, compared with the time required on well-run manual equipments. Curves II and IV show the time which elapses after the subscriber has removed his telephone until the required subscriber is rung, under standard conditions of manual service. Curve III shows the same period for full automatic service.

FACT 3: *Subscribers can satisfactorily operate the calling device.* This has been proved in practical experience to be one of the real facts; the statements to the contrary made in some quarters are merely opinions.

FACT 4: *Properly constructed automatic apparatus is reliable.* The

Digitized by Google

figures for a number of days taken at random from the fault record books in public automatic exchanges show the following averages. The number of exchange faults reported in the form of complaints from subscribers amount to 1·9 per thousand stations per day, or one fault per station every 530 days. The total exchange faults recorded, amount to 5·85 faults per thousand stations per day. In these figures exchange troubles due to all causes are included, for



I.—Manual v. Automatic—Speed Comparisons.

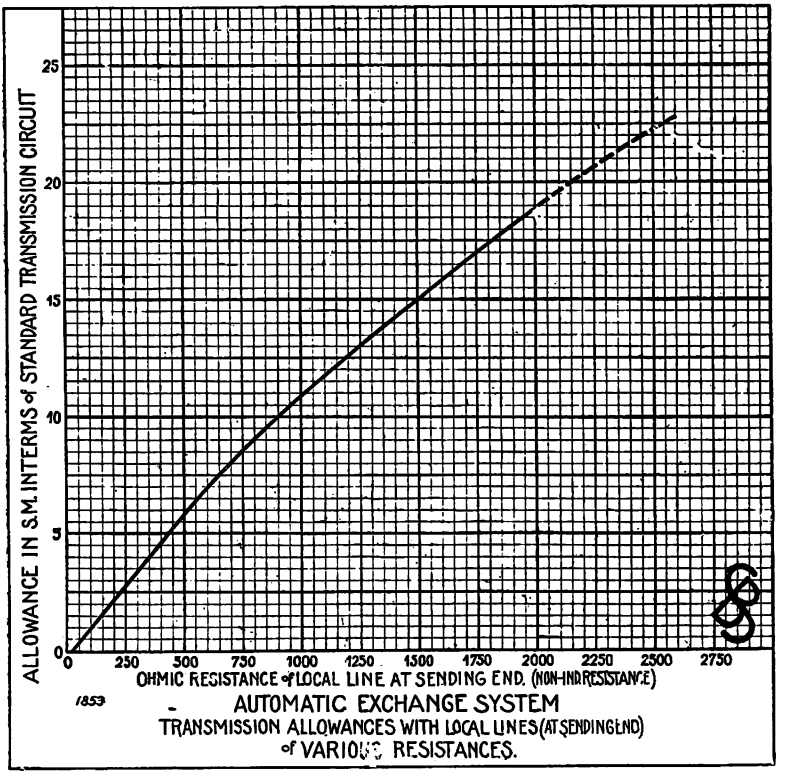
example, faults on auxiliary circuits, faults at the distant ends of junctions, etc., as well as faults on the automatic apparatus, which form a comparatively small proportion.

Fact 5: *Better transmission is obtained on automatic circuits than on the present standard manual circuits.* The curve in 2 shows the combined allowance for a connection on an automatic exchange, with local lines (at sending end) of various resistances, compared with the British standard transmission circuit.

Fact 6: *Automatic telephony has now reached such a stage in its development that it can fulfil the traffic requirements necessary to provide*

Digitized by Google

a satisfactory and economical service. Positive and reliable registration is provided. Private branch exchanges with consecutive or non-consecutive numbers are catered for. Trunk calls are completed over the ordinary junctions and selectors, and take precedence of local calls if desired. Trunk and long-distance junction calls can be made to select the heavy conductor junctions provided for such calls, in preference to the lighter conductor junctions provided for



2.—Transmission Allowances.

local traffic. Special calls, such as calls for lines ceased, service calls, inquiries and complaints are adequately dealt with.

There are, however, several features of existing British C.B. manual telephone service, to which the full automatic, at its present stage of development, does not readily lend itself. In particular the "Postal Facilities Barred" and the "Fees for Special Junction Calls" services may be mentioned.

Fact 7: *The design of automatic exchanges is now based on considerations of the traffic to be catered for.* The statements that are current with regard to the "10 per cent. basis" and "ten junctions per junction group" are incorrect, and ignore the advances which

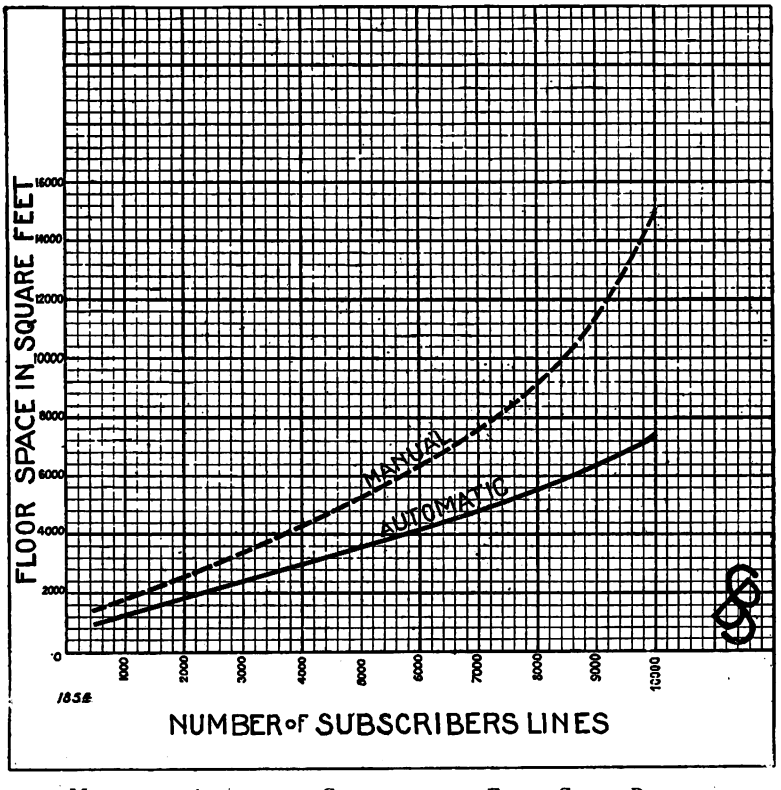
Digitized by Google

have been made during recent years in the methods of designing automatic exchange equipments.

Automatic and manual exchange.			Actual automatic exchange.					Manual exchange of same size.
Exchange.	Number of working lines.	Calls per line per day.	Number of staff.	Approximate total wage paid.	Wages corrected to British practice per ann.			Average cost per line per annum.
					Total wages.	Average per man.	Cost per line.	
A	2300	7·0	8–1*=7	£650	£714	£102	£0·31	£0·2
B	1200	7·5	6–1*=5	£440	£525	£105	£0·437	£0·3

* One man in exchange deals with complaints, enquiries and traffic matters.

3.—Manual v. Automatic—Comparison of Maintenance Costs.



4.—Manual v. Automatic—Comparison of Floor Space Requirements.

Fact 8: *The cost of maintenance of automatic equipments is not excessive compared with that of manual equipments.* The comparison of

Digitized by Google

labour costs for maintenance is shown in 3. These figures do not include office charges or maintenance material. Those for automatic exchanges are based on particulars of the running costs of exchanges in public service, and have been corrected where necessary for the

COMPARISON OF MANUAL, AUTOMATIC AND SEMI-AUTOMATIC SCHEMES FOR A TELEPHONE AREA.

General Data from Development Study.

	First equipment.	Ultimate.
Number of subscribers	6000	18000
Average calls per line per day . . .	11	10
Number of stations	8000	23000

Summary: Automatic and Semi-Automatic Systems compared with a Standard Manual C.B. System.

	Increase = + Decrease = −	Automatic. First equipment.	Automatic. Ultimate.	Semi-automatic. First equipment.	Semi-automatic. Ultimate.
Total subscribers' mileage . . .	decreased by −	16%	12%	16%	12%
Annual charges for:		£	£	£	£
Interest and depreciation on exchange equipments . .	increased by +	2258	3500	2528	4180
Maintenance of exchange equipments	increased by +	581	1095	746	1510
Subscribers' line plant . . .	decreased by −	783	1584	783	1584
Junction line plant .	increased by +	155	374	155	374
Operating . .	decreased by −	8175	20400	5525	14290
Interest and depreciation on subscribers' instruments	increased by +	595	1700	—	—
Maintenance of subscribers' instruments	increased by +	203	578	—	—
Total saving per annum compared with standard Manual C.B. System		£5166	£14737	£2879	£9810

higher wages paid in Great Britain. Those for manual exchanges are well-ascertained figures for the corresponding costs of modern and efficient British exchanges.

FACT 9: *The floor space required for automatic equipments is less than that required for corresponding manual equipments.* The curves

Digitized by Google

given in 4 show the floor space necessary for exchanges of various sizes, with a calling rate of ten calls per line per day. They include the necessary floor space for quarters for maintenance staff and operators in each case.

Up to the present my object has been only to give definite facts with regard to certain features of the automatic system on which little or no information has been published. There remains, of course, the important question of economy. Here definite facts as to the economies effected on one particular area are of little value, since each area must be studied for itself. Further, in the present transition period it is extremely difficult to make a definite comparison of total costs. We are forced, therefore, to fall back on carefully made estimates based upon the study of typical areas, and upon detail costs obtained from observations on working exchanges. Just as an example the results of such a study applied to an actual telephone area to determine the relative costs of manual, semi-automatic and automatic methods of working may be quoted. These results are shown in 5.

Studies such as these clearly show that a very large saving can be effected by the adoption of automatic or semi-automatic systems, but these conditions cannot be reached in one step ; an administration must consider the transition period. In some cases, especially in large areas, the conversion has to be effected gradually, one exchange at a time. In this connection, the semi-automatic system of a type which allows semi-automatic and full automatic subscribers to work side by side offers a very convenient solution. The existing manual exchanges can be converted as desired to semi-automatic, such a change allowing a uniform method of subscribers operating to be maintained throughout the area until the whole is ready for a quick change to the full automatic system.

In conclusion the author regrets that he has had to base the statements made and the figures given above on one system only, namely on the automatic and semi-automatic equipments manufactured and installed by Siemens. He has had no opportunity of investigating other systems, but ventures to express the hope that " facts " about one system will be at least as useful as " opinions " on several.

AUTOMATIC IN AUSTRIA.

THE reform of the Vienna telephone service will be accomplished within the next ten years. It was originally intended to introduce the full automatic system, but the engineer department of the Post and Telegraph Administration gave its decision in favour of the semi-automatic system. Ten semi-automatic exchanges, for 10,000

Digitized by Google

subscribers each, will be established. Three of these exchanges will be built in the first instance. Under the stimulation of the orders placed in connection with these operations, Austrian electrical manufacturing firms are experiencing a period of unwonted prosperity, and several are enlarging their works. Among the latter are the Ericsson Austrian Electrical Manufacturing Co. and the Telephonfabriks-Aktiengesellschaft, both of which are making extensive additions to their works. In addition to the orders already placed, commissions for some 20,000 instruments of various kinds are in sight, besides large orders for telephone cable for the projected lines to Triest and Dalmatia, rendered possible by the 20,000,000 kronen credit for postal purposes included in this year's State Budget.—*Electrical Review.*

TELEPHONE PROGRESS IN LONDON.

By C. W. MUIRHEAD.

SINCE the appearance in this JOURNAL of the last review on telephone progress in London the transfer to the Post Office of the National Telephone Company's system has taken place. The task of reviewing London's telephone system, a review which the Editors of the JOURNAL now appear to regard as an annual fixture, has assumed, therefore, very much larger proportions. At the moment of writing the combined system embraces no less than eighty-two exchanges, with which are connected some 200,000 stations. The acquisition of the Company's system has nearly trebled the number of exchanges under Post Office direction and considerably more than doubled the number of stations.

It is proposed in the course of the present article to show (1) the progress made by the Post Office system for the year ended December 31st, 1911, and (2) the position of the combined Post Office and ex-National system on March 31st, 1912. The reason for the second arrangement is that the date mentioned marks the close of the Post Office financial year, so that in future reviews the period under examination will begin with the beginning of the financial year—a convenient and desirable arrangement.

A review of the progress made by the Post Office London Telephone system during 1911 is in the nature of a valediction. It deals with the last year of the Post Office system as distinct from the combined Post Office and National system which began on January 1st, 1912. The chapter dealing with pre-transfer Post Office enterprise in London is interesting reading. A Select Committee appointed by the House of Commons in 1898, "to inquire and report whether the telephone service was calculated

Digitized by Google

to become of such general benefit as to justify its being undertaken by municipal and other local authorities, regard being had to local finance" reported in favour of competition with the National Telephone Company, both on the part of local authorities and on the part of the Post Office. The recommendations of the Committee were adopted, a Treasury minute announced *inter alia* that the Post Office would establish a telephone system in London, the Telephone Act of 1899 authorised a loan of £2,000,000 chiefly for such purpose, and the Post Office started laying an extensive underground system before the end of the same year. Two years later, on March 1st, 1902, to be precise, the first Post Office Exchange in London—the Central—was opened, subscribers having the benefit, by virtue of an agreement ratified the previous year, of free intercommunication with subscribers of the National Telephone Company.

The new system grew with almost phenomenal rapidity. Over 4000 direct lines were connected at the end of 1902 with the Central Exchange alone. During the same year exchanges were opened at Putney, Kingston, Kensington (Western Exchange), Wimbledon, Westminster (Victoria Exchange), and Richmond. Additional exchanges were established from time to time, until, at the end of 1911, just prior to the amalgamation of the system with that of the National Telephone Company, there were in all thirty-three exchanges, having 52,975 direct lines and 77,317 stations connected with them. The progress made during the last ten years may be better realised when it is pointed out that at the inception of the Post Office system there were only some 25,000 exchange lines in the London area, connected with a system of some twenty years' standing. In less than ten years the Post Office provided 50,000 lines and nearly 80,000 telephones in the London area, a rate of 8000 telephones per year.

The rate of development was maintained at the same level during 1911. 8282 stations were added, which, as will be seen from the following table, was the third largest increase since the commencement of the system.

1902	.	6294	.	First year
1903	.	8007	.	Increase over 1902
1904	.	7880	.	,, ,, 1903
1905	.	8738	.	,, ,, 1904
1906	.	7564	.	,, ,, 1905
1907	.	7872	.	,, ,, 1906
1908	.	6067	.	,, ,, 1907
1909	.	7669	.	,, ,, 1908
1910	.	8944	.	,, ,, 1909
1911	.	8282	.	,, ,, 1910
		77317		

Digitized by Google

The total number of removals carried out for Post Office subscribers during 1911 was 6830, an increase of 604 over the previous year's total. As will be seen from the following table the number of removals increases year by year according to the increase in subscribers' stations, or in other words, the percentage of removals to stations remains fairly constant.

	Stations.	Removals.	Percentage of removals to stations.
1906	38,483	3372	8·76
1907	46,355	4036	8·71
1908	52,422	4395	8·38
1909	60,091	5458	9·08
1910	69,035	6226	9·01
1911	77,317	6830	8·83

It will be seen that the variation in the percentage of removals to stations over a period of six years is less than ·7 per cent.

The disappearance of a number of subscribers each year is, of course, inevitable in every telephone system. With a healthy system the number should be small as compared with the number of incoming subscribers. The following table shows the total number of cessations on the Post Office London system in 1911, and the percentage of cessations to stations as compared with the figures of the three previous years.

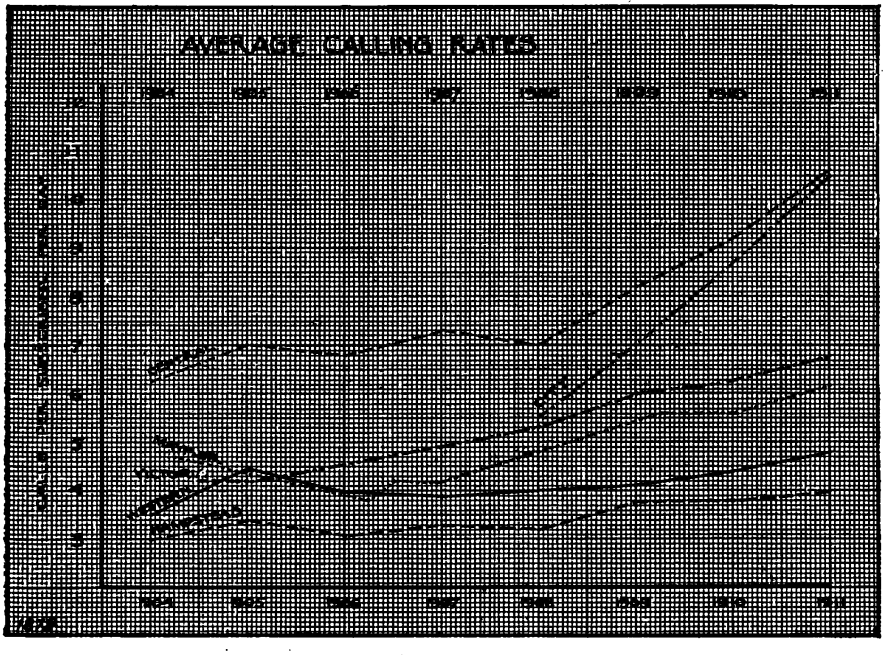
Year.	Deaths.	Bankruptcies.	Giving up business.	Removed unknown.	Business bad.	Leaving area.	Miscellaneous.	Total.	Per cent. to stations.
1908	68	226	188	576	788	308	450	2544	4·8
1909	105	115	170	395	896	572	470	2723	4·5
1910	84	107	157	247	836	877	349	2757	3·9
1911	123	137	136	318	868	1017	571	3170	4·1

It will be seen that the gradual improvement since 1908, a bad trade year, when the percentage of cessations to stations was high, suffered a slight check last year, the percentage being ·2 greater than in the preceding year. This result is mainly attributable to the increase in cessations owing to subscribers leaving the London area. It is significant that the number of cessations due to this cause increases appreciably year by year, the figure of last year being three and a half times greater than that of 1908. The chief reasons are motors and telephones. There is a distinct tendency, which was also noticed by the National Telephone Company during the last few years of its existence, for well-to-do subscribers to migrate further away from town. Keeping their own motors they are to a great extent independent of railways, and the ubiquitous telephone gives them a ready means of communication with the City.

The present telephone age is one of curves and conferences. Few questions can be settled without at least one conference and

Digitized by Google

the curve is omnipresent and omnipotent. Certainly no article or report on any aspect of telephony can safely appear without one or more curves. It is astonishing with what affection and respect the telephone expert regards the presentation of information in the form of a curve. He reads with unconcern information shown in a straightforward way, he regards with indifference statements in plain figures, he scarcely glances at facts in tabular form. But a curve draws him at once, and no matter what point it is intended to demonstrate, he settles down contentedly to analyse, criticise, and discuss.



VARIATION IN CALLING RATE OF SIX LARGE LONDON TELEPHONE EXCHANGES.

The above curve shows the increase in the calling rate per subscriber per day in the case of the six largest exchanges on the Post Office London System. The increase in the case of the Central and City Exchanges is very marked. The Central subscriber, who made on an average six and a quarter calls per day in 1904, made ten and a half calls per day in 1911, and the City subscriber, who made five and a half calls per day in 1908, also made in 1911 ten and a half calls per day, that is to say, in four years he nearly doubled his calling rate. The amount of additional work thrown on the exchanges through the growth of the telephone habit with subscribers is, of course, very large. In the case of "City" the same

Digitized by Google

number of subscribers require nearly double the number of operators to attend to them, and this, of course, necessitates corresponding increase of switchboard accommodation.

As already stated, the transfer of the National Telephone Company's system at the end of 1911 more than doubled the size of the Department's telephone system in London. The precise figures at the transfer were :

	Exchanges.	Stations.
Post Office	33	77,317
National Telephone Company	62	131,506
	95	208,823

It will be seen that, taking the number of exchanges as the basis of comparison, the Post Office system was half the size of the Company's system, but that, taking the stations, the proper basis of comparison, the fraction was $\frac{7}{12}$th. The reason is, of course, that the Company had a comparatively large number of small exchanges as compared with the Post Office.

The following list shows the exchanges, direct lines, and stations on the combined system on March 31st, 1912. It is a sufficiently formidable one, and is, of course, of value in that it marks the starting-point of the combined system, and that in future reviews, which will, as already stated, deal with development for each year ending March 31st, it will form the primary basis of comparison.

Lines and Stations working at March 31st, 1912.

Exchanges.	Lines.	Stations.	Exchanges.	Lines.	Stations.
Avenue	3631	7793	*Bt. forward*	32,482	54,248
Bank	2278	4817	Croydon Nat.	957	1294
Barnet	448	526	,, P.O.	945	1059
Bartholomew Ho.	484	567	Dalston	2497	3150
Battersea	1946	2467	Dartford	102	240
Bexley Heath	136	154	Ealing	1291	1520
Brixton	1958	2337	East	2552	3909
Bromley	1527	1754	East Ham	458	579
Burgh Heath	147	162	Enfield	443	523
Central	13,653	23,654	Epsom	336	399
Chigwell	20	24	Erith	127	180
Chingford	78	81	Esher	206	233
Chiswick	1126	1303	Finchley	1061	1213
City	4968	8521	Gerrard	8878	23,195
Cray	82	88	Hammersmith	1087	1479
Car. forward	32,482	54,248	*Car. forward*	53,422	93,221

Digitized by Google

Exchanges.	Lines.	Stations.
Bt. forward	53,422	93,221
Hampstead Nat.	564	798
,, P.O.	4876	5494
Harrow	419	496
Holborn	4723	10,116
Hop	3750	6362
Hornsey	1443	1585
Hounslow	176	202
Ilford	520	619
Kensington	4611	6912
Kingsbury	83	95
Kingston Nat.	221	345
Kingston P.O.	1168	1382
Lee Green	1409	1610
London Wall	8819	18,848
Loughton	113	126
Malden	106	113
Mayfair	5567	8338
Merstham	56	61
Mitcham	80	98
Molesey	216	246
New Cross	1572	2058
North	3359	4933
Official Switch	245	352
Paddington	5512	8994
Palmers Green	637	731
Purley	497	536
Putney	1507	1704
Car. forward	105,671	176,375

Exchanges.	Lines.	Stations.
Bt. forward	105,671	176,375
Rainham	26	29
Redhill	356	424
Reigate	220	265
Richmond	1243	1466
Romford	166	202
Sidcup	248	275
Southall	107	206
Stratford	694	832
Streatham	1330	1504
Sutton	860	980
Sydenham	1782	2162
Tilbury	172	217
Tottenham	724	980
Treasury	174	245
Trunk	113	142
Victoria	5638	12,201
Waltham Cross	141	204
Walthamstow	567	718
Wanstead	466	521
Wembley	127	154
Western	5941	7461
Willesden	1247	1467
Wimbledon Nat.	170	260
,, P.O.	1060	1196
Woodford	244	276
Woolwich	549	741
Total	130,036	211,503

The difference between the number of exchanges in the above list—82—and the number at the transfer—95—is due to the fact that it has been found desirable on economical grounds to close thirteen of the National exchanges, transferring, of course, the subscribers to other exchanges. The exchanges dealt with in this summary way were: Barnet, Ealing, Epsom, Esher, Finchley, Harlesden, Harrow, Molesey, Purley, Richmond, Sutton, Southall, and Westminster. In addition, the old Avenue Exchange was substituted by a new Avenue Exchange built in Creechurch Lane. Six other exchanges, viz. Bank, Croydon, Hampstead, Ilford, Kingston, and Wimbledon, will have to undergo similar treatment before the troubles of the transfer are over, and it is probable that, by the time this article appears in print, the operation will have been partially performed in the case of five of these exchanges.

Digitized by Google

Considering the amount and character of the work involved, the work of transfer has been carried out in London with creditable smoothness, and attended with comparatively little complaint from subscribers. Although it is not the case, as has been said, that one subscriber transferred from the Company is more to the Department than many Post Office subscribers who need no transfer, it is the case that the Department has wisely done everything possible to reduce to a minimum the inconvenience caused to subscribers by the transfer of their lines and the alteration of their numbers.

It is, of course, too early to discuss the general effects of the transfer on telephone work and telephone organisation in London. It is hoped to deal with this aspect of the subject in a further article.

TELEPHONE TRANSMISSION.

By F. ADDEY, B.Sc.

(*Continued from page* 40.)

THE theory of telephone transmission has been greatly simplified by the use of what are known as "hyperbolic functions." The reason why this particular name has been given to these quantities is not necessary for our purpose; we may take the following as definitions:

The hyperbolic cosine of x, or $\cosh x$, $= \frac{e^x + e^{-x}}{2}$.

The hyperbolic sine of x, or $\sinh x$, $= \frac{e^x - e^{-x}}{2}$.

The hyperbolic tangent of x, or $\tanh x$, $= \frac{\sinh x}{\cosh x} = \frac{e^x - e^{-x}}{e^x + e^{-x}}$.

The values of these hyperbolic functions can be obtained from tables.

It is shown in books on higher trigonometry that—

$$\cos x = \frac{e^{ix} + e^{-ix}}{2}$$

$$\sin x = \frac{e^{ix} - e^{-ix}}{2i}$$

In all the foregoing formulæ x is in radians.

Hence we have—

$$\cosh i\beta = \frac{e^{i\beta} + e^{-i\beta}}{2} = \cos \beta$$

$$\sinh i\beta = \frac{e^{i\beta} - e^{-i\beta}}{2} = \frac{i\,e^{i\beta} - e^{-i\beta}}{2i} = i \sin \beta.$$

Digitized by Google

By adding and subtracting the exponential forms given above, we obtain

$$\cosh x + \sinh x = e^x$$
$$\cosh x - \sinh x = e^{-x}.$$

There are double angle formulæ for these hyperbolic functions similar to the ordinary trigonometrical formulæ. Thus:

$$\sinh (x + y) = \frac{e^{(x+y)} - e^{-(x+y)}}{2}$$
$$= \frac{e^x e^y - e^{-x} e^{-y}}{2}.$$

By substituting the values for e^x and e^{-x}, etc., just obtained, and multiplying up, we obtain—

$$\sinh (x+y) = \sinh x \cosh y + \cosh x \sinh y.$$

In a similar manner we obtain—

$$\cosh (x+y) = \cosh x \cosh y + \sinh x \sinh y.$$

Hence—

$$\sinh (\alpha+i\beta) = \sinh \alpha \cosh i\beta + \cosh \alpha \sinh i\beta$$
$$= \sinh \alpha \cos \beta + i \cosh \alpha \sin \beta.$$

Similarly—

$$\cosh (\alpha+i\beta) = \cosh \alpha \cos \beta + i \sinh \alpha \sin \beta.$$

These formulæ for the hyperbolic functions of complex quantities are required in connection with the solution of actual numerical telephone transmission problems.

In connection with the investigation of telephone transmission, a differential equation occurs of the form—

$$\frac{d^2y}{dx^2} = a^2 y.$$

The following equations are solutions of this differential equation—

$$y = Me^{ax} + Ne^{-ax}$$
$$y = P \cosh ax + Q \sinh ax.$$

This may easily be shown as follows:

Taking the first solution, we have—

$$\frac{dy}{dx} = aMe^{ax} - aNe^{-ax}$$

$$\text{and } \frac{d^2y}{dx^2} = a^2Me^{ax} + a^2Ne^{-ax}$$
$$= a^2 (Me^{ax} + Ne^{-ax}) = a^2 y.$$

To differentiate the second solution, we have to differentiate cosh ax and sinh ax.

$$\text{Let } y = \cosh ax = \frac{e^{ax} + e^{-ax}}{2},$$

$$\text{therefore } \frac{dy}{dx} = \tfrac{1}{2} (ae^{ax} - ae^{-ax}) = a \left[\frac{e^{ax} - e^{-ax}}{2}\right] = a \sinh ax.$$

$$\text{Also, if } y = \sinh ax = \frac{e^{ax} - e^{-ax}}{2},$$

Digitized by Google

$$\text{we have } \frac{dy}{dx} = \tfrac{1}{2}(ae^{ax} + ae^{-ax})$$

$$= a\left[\frac{e^{ax} + e^{-ax}}{2}\right] = a\cosh ax.$$

Hence taking the second solution given above we have

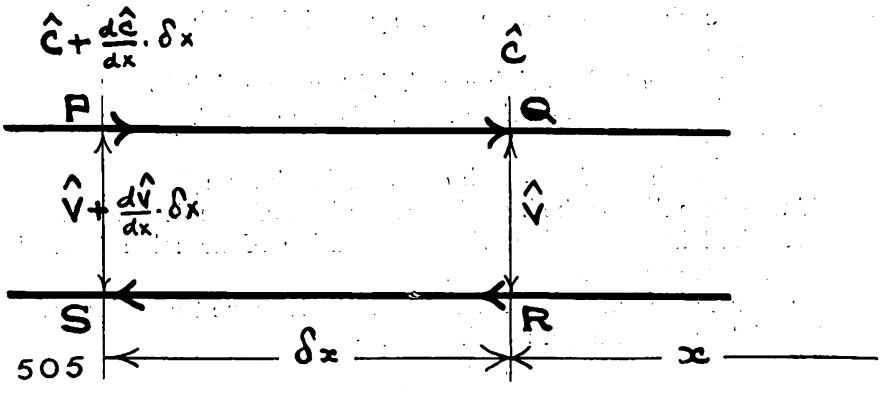
$$\frac{dy}{dx} = a\,P\sinh ax + aQ\cosh ax,$$

$$\text{and } \frac{d^2y}{dx^2} = a^2P\cosh ax + a^2Q\sinh ax$$

$$= a^2(P\cosh ax + Q\sinh ax)$$

$$= a^2y.$$

THEORY OF THE PROPAGATION OF A SIMPLE HARMONIC CURRENT ALONG A TELEPHONE LINE.—Let $PQRS$ (6) be an element, of



6.—ELEMENT OF TELEPHONE CIRCUIT.

length δx, of a telephone circuit having the following constants per unit length of loop:—

Resistance, R. Ohms.
Inductance, L. Henrys.
Capacity, K. Farads.
Leakance, S. Mhos.

The leakance is the reciprocal of the insulation resistance per unit length.

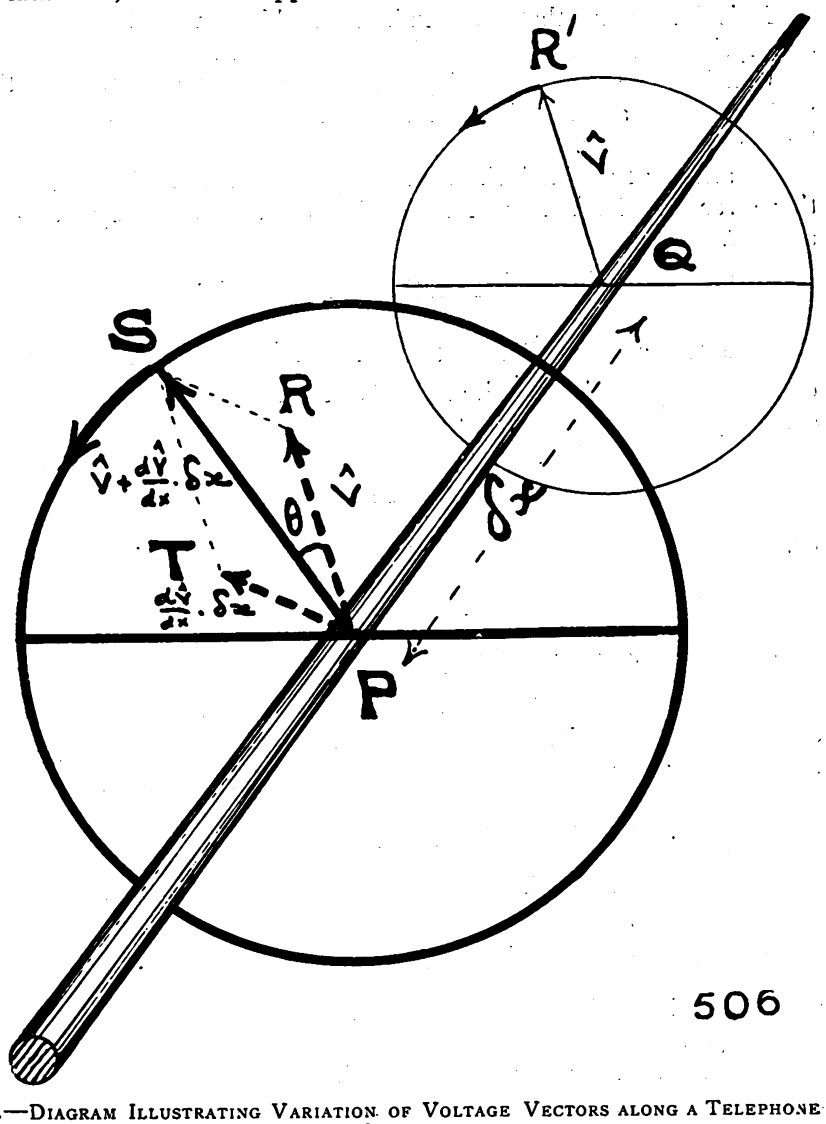
It should be remembered that the values of these constants are not the values as measured by a steady current, but are the values which the electrical quantities possess at the particular frequency under consideration.

Let the vector volts and current at Q be respectively $\hat{V}$ and $\hat{C}$. If we measure x from the receiving end of the circuit we shall have the vector volts and current at P respectively—

$$\hat{V} + \frac{d\hat{V}}{dx}\delta x \text{ and } \hat{C} + \frac{d\hat{C}}{dx}\delta x.$$

Digitized by Google

The current at R will always be equal to that at Q, but in the opposite direction. Similarly the current at S will always be equal to that at P, but in the opposite direction.



7.—Diagram Illustrating Variation of Voltage Vectors along a Telephone Circuit.

We may therefore consider the element $PQRS$ as forming a closed circuit without altering the distribution of current in the element. There will be a vector voltage $\hat{V} + \frac{d\hat{V}}{dx}\delta x$, acting round this circuit in one direction, and a vector voltage $\hat{V}$ acting round the

Digitized by Google

circuit in the opposite direction. The resultant vector voltage will therefore be $\frac{d\hat{V}}{dx}\delta x$.

It is important that the student should form a clear physical conception of the meaning of this last statement.

Consider the two clock diagrams shown in 7, representing the vector voltage, at the points P and Q on the circuit (6), separated by the distance δx.

As already explained, there will be a difference of phase between these vectors, the vector at P leading on that at Q by a certain angle θ.

If the vector $\hat{QR^1}$ be $\hat{V}$, then the vector $\hat{PS}$ will be $\hat{V} + \frac{d\hat{V}}{dx}\delta x$.

Resolve the vector $\hat{PS}$ into two components $\hat{PR}$, $\hat{PT}$, making $\hat{PR}$ equal and parallel to $\hat{QR^1}$, and $\hat{PT}$ of the necessary size and in the correct position to complete the parallelogram $PRST$.

Then we have the vector equation

$$\hat{PR} + \hat{PT} = \hat{PS}$$

or,
$$\hat{V} + \hat{PT} = \hat{V} + \frac{d\hat{V}}{dx}\delta x$$

Hence
$$PT = \frac{d\hat{V}}{dx}\delta x$$

Since the whole clock diagram for the point P rotates with the same speed as the vector $\hat{QR'}$, it follows that, round the element of circuit $PQRS$ (6) the instantaneous voltages due to the vector voltages $\hat{QR^1}$ and $\hat{PR}$ always exactly neutralise one another. We have therefore left the resultant vector voltage $\frac{d\hat{V}}{dx}\delta x$ acting round the element and rotating with the same frequency as that of the harmonic voltage under consideration.

That is, an harmonic voltage, of maximum value $\frac{dV}{dx}\cdot\delta x$, will be acting round the circuit element $PQRS$.

Let C be the instantaneous value of the current at Q, where $c = C \sin pt$. Since δx is very small, we may assume that C is constant round the circuit $PQRS$. Now c varies harmonically, and therefore the voltage driving c will also vary harmonically with the same frequency, but, in general, the voltage and current will not be in phase with one another. If we denote this phase difference by θ, we have the following equation of instantaneous values.

$$\left(\frac{dV}{dx}\delta x\right) \sin (pt + \theta) = R\ \delta x\ c + L\ \delta x \frac{dc}{dt}$$

Digitized by Google

or $$\frac{dV}{dx} \sin (pt + \theta) = Rc + L\frac{dc}{dt}$$

Now $c = C \sin pt$, and therefore $\frac{dc}{dt} = pC \cos pt$.

Hence $\frac{dV}{dx} \sin (pt + \theta) = RC \sin pt + pLC \cos pt$.

By representing this equation graphically, as in **8**, it can be at once seen that the vector $\frac{d\hat{V}}{dx}$ is the sum of the two vectors $R\hat{C}$ and $pL\hat{C}$, which are at right angles to one another.

Hence we have the vector equation.

$$\frac{d\hat{V}}{dx} = R\hat{C} + ipL\hat{C},$$

or $$\frac{d\hat{V}}{dx} = (R + ipL)\hat{C} \quad . \quad . \quad . \quad . \quad (1)$$

The vector current at P is $\hat{C} + \frac{d\hat{C}}{dx}\delta x$, and the vector current at Q is $\hat{C}$. The vector current at P therefore exceeds that at Q by the amount $\frac{d\hat{C}}{dx}\delta x$. This excess current is made up partly by the current leaking across from one wire to the other through the insulation, and partly by the current flowing in to charge the capacity of the portion δx. The current flowing through a leakance S, due to a voltage V, will be SV, while the current flowing in to charge a capacity K, since quantity $Q = KV$ and current $= \frac{dQ}{dt}$, will be $K\frac{dV}{dt}$.

Since δx is very small we may assume the voltage to have over the whole length of the element the same instantaneous value $v = V \sin pt$ which it has at Q.

We have, therefore, the following equation of instantaneous values:

$$\left(\frac{dC}{dx}\delta x\right) \sin (pt + \phi) = S\,\delta x\, v + K\,\delta x \frac{dv}{dt},$$

or $$\frac{dC}{dx} \sin (pt + \phi) = Sv + K\frac{dv}{dt}.$$

Now $v = V \sin pt$ and therefore $\frac{dv}{dt} = pV \cos pt$.

Hence $\frac{dC}{dx} \sin (pt + \phi) = SV \sin pt + pKV \cos pt$.

Thus by a diagram similar to **8**, we see that the vector $\frac{d\hat{C}}{dx}$ is the sum of the two vectors $S\hat{V}$ and $pK\hat{V}$, at right angles to one another.

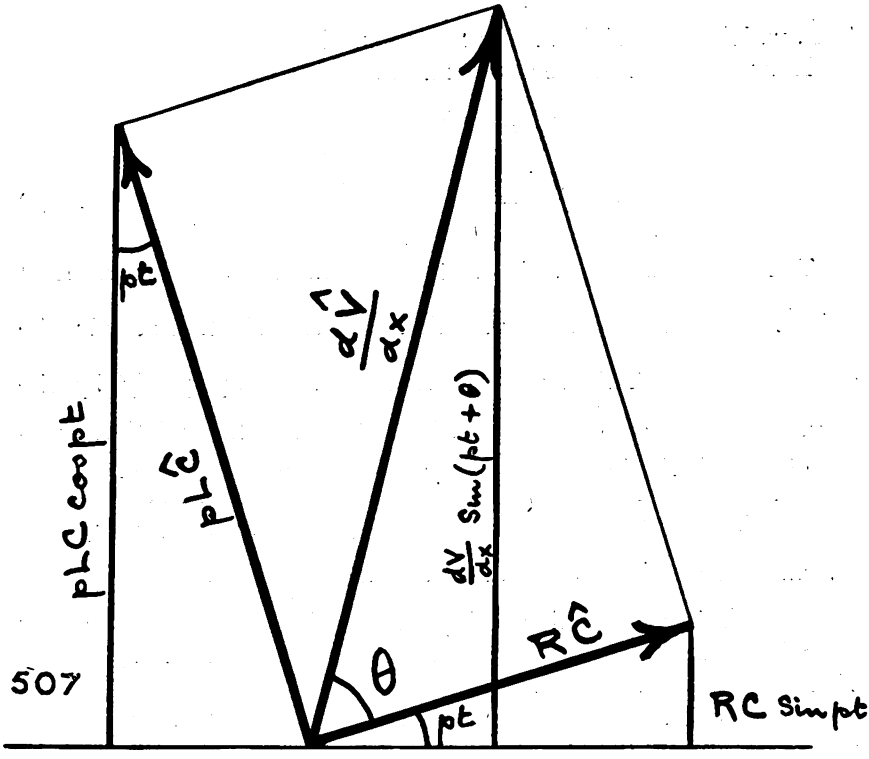
Hence we have the vector equation—

Digitized by Google

$$\frac{d\hat{C}}{dx} = S\hat{V} + iPK\hat{V}$$

$$\text{or } \frac{d\hat{C}}{dx} = (S + ipK)\,\hat{V} \quad . \quad . \quad . \quad (2)$$

The quantities $(R + ipL)$ and $(S + ipK)$ which occur in equations (1) and (2) are vectors. They are known respectively as the vector impedance and the vector admittance, per unit length.



8.—Vector Diagram for Current and Voltage in Element of Telephone Circuit.

Let $(R + ipL) = I$ and $(S + ipK) = \hat{Y}$.

Then equation (1) becomes $\frac{dV}{dx} = \hat{I}\hat{C}$

and equation (2) becomes $\frac{dC}{dx} = \hat{Y}\hat{V}$.

Differentiating, we obtain

$$\frac{d^2\hat{V}}{dx^2} = \hat{I}\frac{d\hat{C}}{dx} = \hat{I}\hat{Y}\hat{V} \text{ and } \frac{d^2C}{dx^2} = Y\frac{dV}{dx} = \hat{I}\hat{Y}\hat{C}.$$

Digitized by Google

Each of these equations is of the form $\frac{d^2y}{dx^2} = a^2y$

where $a = \sqrt{\hat{I}\hat{Y}}$.

Hence, as shown in the previous section

$$\hat{C} = Me^{ax} + Ne^{-ax} \quad . \quad . \quad . \quad . \quad . \quad (3)$$

and $\hat{C} = P \cosh ax + Q \sinh ax \quad . \quad . \quad . \quad (4)$

where M, N, P, Q are constants.

Equations of similar form of course hold good for $\hat{V}$.

Consider first equation (3),

$$\hat{C} = \mathrm{M}e^{ax} + \mathrm{N}e^{-ax}.$$

In this equation x is measured from the receiving end of the circuit. The further away we get from the receiving end the larger the first term becomes and the smaller the second term becomes.

The second term represents the waves reflected from the receiving end. If the circuit be so long that at the point we are considering the reflected current is negligible, we may write

$$\hat{C} = \mathrm{M}e^{ax}.$$

It is more convenient to measure a from the sending than from the receiving end. If this be done, and if the length of the circuit be l, our old x becomes $l-x$, where x is now measured from the sending end.

$$\text{Hence } \hat{C} = Me^{a(l-x)}$$
$$= Me^{al}\, e^{-ax}$$

At the sending end $x = O$. Hence, if we denote the current vector at the sending end by C^o, we have—

$$C_o = Me^{al}\, e^o = Me^{ul}.$$

$$\text{Hence } \hat{C} = \hat{C}_o e^{-ax}.$$

Thus the current vector at a point x units along the line is less than the current vector at the sending end, in the ratio $\frac{1}{e^{ux}}$.

Now $a = \sqrt{\hat{I}\hat{Y}}$, which is a vector, and it can consequently be expressed in the complex form, $\hat{a} = \alpha + i\beta$. $\hat{a}$ is therefore known as the "complex attenuation co-efficient."

Thus we have $\hat{C} = \hat{C}_o e^{-(\alpha + i\beta)x} = \hat{C}_o\, e^{-\alpha x}\, e^{-i\beta x}$. α is an ordinary algebraical quantity. Therefore $e^{-\alpha x}$ is a simple multiplier, which diminishes as x increases. The magnitude of $\hat{C}_o e^{-\alpha x}$ therefore diminishes as x increases, and the rate of diminution depends on the value of α.

Hence α is known as the *attenuation constant.*

Remembering the method of representing a vector by the form $\hat{A} = A\, e^{i\theta}$ it follows that $e^{-\beta x}$ represents a vector of length 1, having an angle $-\beta x$.

Digitized by Google

Hence by the rule for the multiplication of vectors, the effect of multiplying the vector $\hat{C}_o e^{-\alpha x}$ by the vector $e^{-i\beta x}$ is to shift it backwards through an angle βx.

Thus the equation—

$$\hat{C} = \hat{C}_o e^{-\alpha x}\, e^{-i\beta x}$$

means that at a distance x along the circuit, measured from the sending end, the current vector, which had the value $\hat{C}_o$ at the sending end, has been diminished to the value $\hat{C}_o e^{-\alpha x}$, and has been shifted backwards by an angle βx from the current vector at the sending end.

If x be such a length that the current vector there is shifted backwards an entire revolution, or 2π radians, we shall have in the length x one complete wave. If the wave-length be denoted by λ we have therefore

$$\beta\lambda = 2\pi$$

$$\text{or} \quad \lambda = \frac{2\pi}{\beta}.$$

The velocity of propagation is given by—

$$v = n\lambda = \frac{2\pi n}{\beta}.$$

Hence β is known as the *wave-length constant*, or the *velocity constant*.

To express α and β in terms of the electrical constants of the circuit we proceed as follows:

We have $\hat{a} = \alpha + i\beta = \sqrt{\hat{I}\hat{Y}}$

therefore $a^2 = \alpha^2 + \beta^2 = IY$

Also $\hat{I} = R + ipL$ and $\hat{Y} = S + ipK$,

hence $I = \sqrt{R^2 + p^2L^2}$, and $Y = \sqrt{S^2 + p^2K^2}$.

Therefore $a^2 = \alpha^2 + \beta^2 = \sqrt{(R^2 + p^2L^2)(S^2 + p^2K^2)}$ . . . (5)

Also $\hat{a}^2 = (\alpha + i\beta)^2 = \alpha^2 + 2i\alpha\beta - \beta^2$

$$= (\alpha^2 - \beta^2) + i(2\alpha\beta),$$

and also $\hat{a}^2 = \hat{I}\hat{Y} = (R + ipL)(S + ipK)$

$$= RS - p^2LK + ip(KR + SL);$$

Hence $(\alpha^2 - \beta^2) + i(2\alpha\beta) = (RS - p^2LK) + ip(KR + SL)$.

Each side of this equation represents a vector, and since these vectors are equal to one another it follows from the diagram (4) that the horizontal or real components, and the vertical or imaginary components, are separately equal to one another.

Hence $\alpha^2 - \beta^2 = RS - p^2LK$ . . . . . (6)

Hence, adding equations (5) and (6) we obtain—

$$2\alpha^2 = \sqrt{(R^2 + p^2L^2)(S^2 + p^2K^2)} + (RS - p^2LK),$$

$$\text{or } \alpha = \sqrt{\tfrac{1}{2}\left[\sqrt{(R^2 + p^2L^2)(S^2 + p^2K^2)} + (RS - p^2LK)\right]}$$

Digitized by Google

Also, subtracting equation (6) above from equation (5) we obtain

$$2\beta^2 = \sqrt{(R^2 + p^2L^2)(S^2 + p^2K^2)} - (RS - p^2LK),$$

$$\text{or } \beta = \sqrt{\tfrac{1}{2}\left[\sqrt{(R^2 + p^2L^2)(S^2 + p^2K^2)} - (RS - p^2LK)\right]}.$$

Thus, knowing the value of α and β, the magnitude of the current and voltage vectors in a telephone circuit at a point sufficiently far from the extremity of the line for reflection effects to the negligible, can be calculated, if we know the magnitude of these quantities at the sending end of the line. In practice, however, we are more concerned with virtual values than with maximum values. But since the virtual value of current or voltage is always $\frac{1}{\sqrt{2}}$ of the maximum value, the previous investigations also hold good for virtual values.

The results just obtained have been deduced from equation (3). By the use of equation (4) results can be obtained which are also extremely valuable.

We have $\hat{C} = P \cosh ax + Q \sinh ax \quad . \quad . \quad . \quad . \quad (7)$

$$\text{Also } \frac{d\hat{C}}{dx} = \hat{Y}\hat{V} = aP \sinh ax + aQ \cosh ax.$$

$$\text{Hence } \hat{V} = \frac{1}{\hat{Y}} \frac{d\hat{C}}{dx} = \frac{a}{Y}[P \sinh ax + Q \cosh ax].$$

$$\text{But } a = \sqrt{\hat{I}\hat{Y}}.$$

$$\text{Hence } \hat{V} = \sqrt{\frac{\hat{I}}{\hat{Y}}}\,[P \sinh ax + Q \cosh ax] \quad . \quad . \quad (8)$$

It will be remembered that in the above equations, x is measured from the receiving end. Hence at the receiving end we have $x = o$; $\cosh ax = \cosh o = 1$; $\sinh ax = \sinh o = 0$.

If $\hat{V}_r$ and $\hat{C}_r$ be the values of the voltage and current vectors at the receiving end, we shall have—

$$\hat{C}_r = P \text{ from (7)},$$

$$\text{and } \hat{V}_r = \sqrt{\frac{\hat{I}}{\hat{Y}}}\, Q \text{ from (8)}.$$

If $\hat{Z}_r$ be the impedance of the receiving instrument, we shall have $\hat{V}_r = \hat{Z}_r\, \hat{C}_r$.

$\hat{Z}_r$ will be a vector, for it not only multiplies the magnitude of the current vector to give the magnitude of the voltage vector, but it also gives the phase angle between these two vectors.

$$\text{Hence } \hat{Z}_r\, \hat{C}_r = \sqrt{\frac{\hat{I}}{\hat{Y}}}\, Q;$$

Digitized by Google

$$\text{Therefore } Q = \hat{Z}_r \sqrt{\frac{\hat{Y}}{\hat{I}}} \hat{C}_r,$$

and we have already found that $P = \hat{C}_r$.

Hence equations (7) and (8) become—

$$C = [\text{Cosh } ax + \hat{Z}_r \sqrt{\frac{\hat{Y}}{\hat{I}}} \sinh ax] \hat{C}_r \quad . \quad . \quad . \quad (9)$$

$$\text{and } \hat{V} = \sqrt{\frac{\hat{I}}{\hat{Y}}} [\sinh ax + \hat{Z}_r \sqrt{\frac{\hat{Y}}{\hat{I}}} \cosh ax] \hat{C}_r \quad . \quad (10)$$

Consider a circuit of length l. Let $\hat{V}_o$ and $\hat{C}_o$ be the vector voltage applied to the sending end, and the resulting vector current respectively. Then the apparent impedance of this circuit, as observed at the sending end, is

$$\frac{\hat{V}_o}{\hat{C}_o} = \hat{Z}_1 \text{ (say)} = \sqrt{\frac{\hat{I}}{\hat{Y}}} \left[\frac{\sinh al + \hat{Z}_r \sqrt{\frac{\hat{Y}}{\hat{I}}} \cosh al}{\cosh al + \hat{Z}_r \sqrt{\frac{\hat{Y}}{\hat{I}}} \sinh al} \right]$$

from equations (9) and (10) above.

Dividing above and below by cosh al, we obtain—

$$\hat{Z}_1 = \sqrt{\frac{\hat{I}}{\hat{Y}}} \left[\frac{\tanh al + \hat{Z}_r \sqrt{\frac{\hat{Y}}{\hat{I}}}}{1 + \hat{Z}_r \sqrt{\frac{\hat{Y}}{\hat{I}}} \tanh al} \right] \quad . \quad . \quad . \quad (11)$$

This is called the "*impedance at the sending end.*"

Suppose now the line to be very long. We have—

$$\tanh al = \frac{\sinh al}{\cosh al} = \frac{e^{al} - e^{-al}}{e^{al} + e^{-al}}.$$

As l increases, e^{-al} decreases, and when l is very great, e^{-al} can be neglected.

Therefore in this case $\tanh al = 1$, and equation (11) becomes

$$\sqrt{\frac{\hat{Y}}{\hat{I}}} \left[\frac{1 + \hat{Z}_r \sqrt{\frac{\hat{Y}}{\hat{I}}}}{1 + \hat{Z}^r \sqrt{\frac{\hat{Y}}{\hat{I}}}} \right] = \sqrt{\frac{\hat{I}}{\hat{Y}}}$$

This quantity is only dependent on the electrical constants of the line. It is called the "*sending end impedance,*" or, better, the "*characteristic impedance*" of the circuit, and is denoted by $\hat{Z}$.

Digitized by Google

$$\text{Thus } \hat{Z}_o = \sqrt{\frac{\hat{I}}{\hat{Y}}} = \quad . \quad . \quad . \quad . \quad (12)$$

Substituting $\hat{Z}_o$ for $\sqrt{\frac{\hat{I}}{\hat{Y}}}$ in equations (9), (10) and (11) we obtain—

$$\hat{C}_o = \left[\cosh al + \frac{\hat{Z}_r}{Z_o} \sinh al\right] \hat{C}_r \quad . \quad . \quad . \quad . \quad (13)$$

$$\hat{V}_o = \left[\hat{Z}_o \sinh al + \hat{Z}_r \cosh al\right] \hat{C}_r \quad . \quad . \quad . \quad (14)$$

$$\hat{Z}_1 = \hat{Z}_o \left[\frac{\tanh al + \frac{\hat{Z}_r}{\hat{Z}_o}}{1 + \frac{\hat{Z}_r}{Z_o} \tanh al}\right] \quad . \quad . \quad . \quad . \quad . \quad (15)$$

The ratio of the voltage at the *sending* end of the line to the current at the *receiving* end is called the "*receiving end impedance.*" This must be clearly distinguished from the impedance of the receiving instrument.

If we denote the receiving end impedance by $\hat{Z}_2$, we have, from equation 14,

$$\hat{Z}_2 = \frac{\hat{V}_o}{\hat{C}_r} = \hat{Z}_o \sinh al + \hat{Z}_r \cosh a \quad . \quad . \quad . \quad (16)$$

With the formulæ just obtained we can calculate the voltage and current at any point in a circuit at a given distance from the receiving end.

We have previously obtained the formula $C = \hat{C}_o e^{-ax}$, which gives the value of the current at a distance x from the sending end of an infinitely long circuit, when the current at the sending end is known.

Now— $$e^{-ax} = \frac{1}{e^{ax}} = \frac{1}{\cosh ax + \sinh ax};$$

Hence— $$\hat{C} = \frac{\hat{C}_o}{\cosh ax + \sinh ax}.$$

This equation may also be deduced from equation (13). We may look upon the cable beyond the point x as forming the receiver of the circuit between the sending end and x. Since the cable is assumed to be infinitely long, the impedance at the sending end of this distant portion will be $\hat{Z}_o$, and this will correspond to $\hat{Z}_r$ in equation (13). By writing $\hat{Z}_o$ for $\hat{Z}_r$, this equation then becomes—

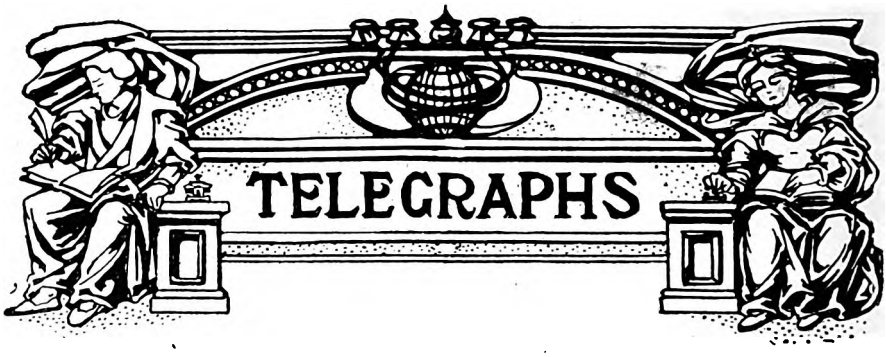
$$\hat{C}_o = [\cosh ax + \sinh ax]\, \hat{C}_r$$

or— $$\hat{C}_r = \frac{\hat{C}_o}{\cosh ax + \sinh ax}.$$

Thus the results obtained by the use of equation (3) agree with those obtained from equation (4).

(To be continued.)

Digitized by Google



THE PRESENT-DAY CENTRAL BATTERY OMNIBUS TELEGRAPH CIRCUIT.

By E. V. Smart.

Although the original simple C.B. omnibus circuit of Messrs. T. F. Purves and C. J. Mercer remains unaltered in principle, a number of modifications have been made in matters of detail, the reasons for which will, no doubt, be of interest to those who have such circuits to maintain, and to others engaged in telegraphy.

To commence at the beginning—the battery. Although 80 is the most usual voltage, 60, 40 and even 30 volts are often used, because, provided there be sufficient margin to allow for the drop in voltage due to the insulation of the line, no advantage is to be gained by using a high pressure, but rather the reverse. A high electrical pressure on the insulation of the conductors is detrimental, as it finds out the weak spots in the line, and, sooner or later, unless detected in time, breaks down the circuit.

The first point, then, is: *Keep the voltage as low as possible consistent with the efficiency of the circuit.*

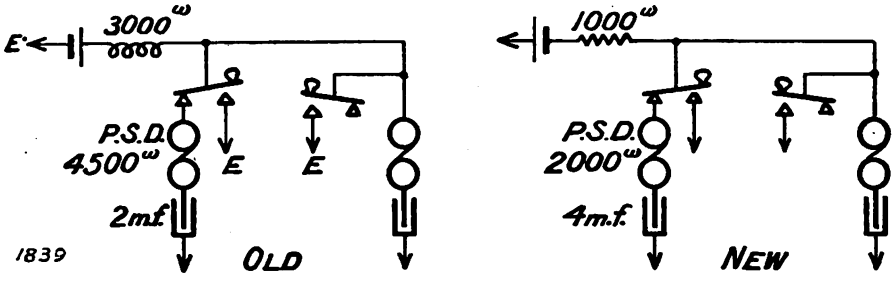
The next consideration is: Which pole of the battery shall be to line? To find the answer we must look at the process of electrolysis. We know that hydrogen and the metals go in the direction of the current, and are deposited at the kathode. Let us assume a copper conductor, to which is connected the positive pole of a battery, lying at one part of its length on the ground, or in close proximity with earth, in acidulated water. The copper will be decomposed, and a copper oxide formed. This process soon leaves the conductor much reduced in diameter, and if the wire is subject to vibration, it is liable to break at any moment at this point. If the negative pole of the battery be connected to the conductor, the copper will either be kept clean, or become coated with some element found on the surface of the ground or earth-connected surface. In this case it may be

Digitized by Google

built up, but cannot be reduced in diameter. In practice, when the negative pole of the battery is consistently kept to line, we do not experience disconnections following partial earths or low insulation, as we do when the positive pole of the battery is to line.

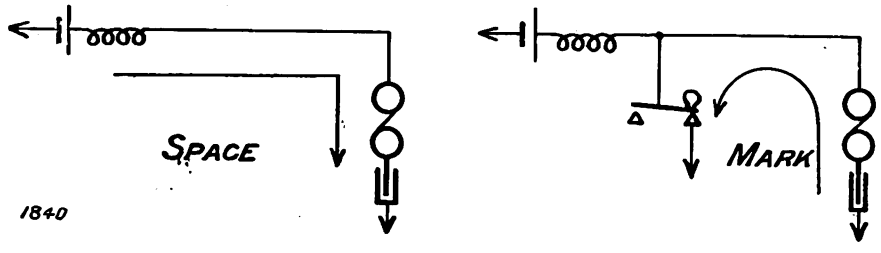
Second point: *The negative pole of the battery should be normally connected to line to prevent electrolytic decomposition of the conductor.*

The value and form of the feed resistance are details around



I.—C.B. Telegraph Circuits.

which there have been many discussions. Let us take "inductive" or "non-inductive" first. When inductive resistance was used, it was found that the E.M.F. of self-induction accelerated the charging of the condensers in circuit, and that this was—so far as it is beneficial—most beneficial in damp weather. But other difficulties then began to appear. The inductive coils broke down; and the first signals of messages were sometimes lost. These troubles were due to the E.M.F. of self-induction (*a*) breaking down the insulation of



2.—Spacing and Marking Signals.

the coils, and (*b*) overcharging the condensers, so that when the battery voltage became operative on the line, the condenser had to discharge instead of charge. Let me make this point clear.

A current flowing *from* the battery to charge the condensers produces a spacing current through the sounder; a current flowing from the condensers to the earth, provided by depressing a key, produces a marking current through the sounder.

Suppose that the head office key had been depressed and the condensers at the out offices are discharged. On raising the key

Digitized by Google

the sudden cessation of the current flowing through the inductive coil produces an E.M.F. of self-induction which rises to the order of 200 volts. This E.M.F. raises the potential of the condensers at the out office to 200^{v}, so producing a space. The E.M.F. of self-induction subsides, leaving the battery voltage 80^{v} to line. Now the condensers had to fall from 200^{v} to 80^{v}. This, being a discharge of the condensers, gave marks, and as it was a final movement of the key the armatures of the sounder were left *down*. It will be clear that what is wanted is the rise from "0" to "80" to produce a space, and not a rise from "0" to "200" followed by a drop from 200^{v} to 80^{v}. The sounder made an extra movement and left the armature down, and the movement down was often a lost signal in the succeeding word. The advantage of the inductive resistance was very slight, and more real in theory than in practice.

The third point is, therefore: *The feed resistance should be of a non-inductive type.*

What shall the value of the feed be? This, to be a fixed value, was a conundrum, for theoretically a different value for each line is necessary, and it should be varied as the insulation changes. *Practically*, these readjustments are impossible on minor circuits; nor did we wish to spend thirty shillings where four shillings would do almost as well. It was therefore decided to use a resistance coil of fixed value, and the problem of finding the most suitable value was undertaken.

It is to be noted at the outset that the spacing and marking currents have different circuits, the polarised sounder and condenser being common to both. A feed resistance ideal for one mark may be most unsatisfactory for a sequence of signals owing to defective spacing.

It is also important to know the minimum voltage change at the head office condenser that operates the receiving instrument in use. A polarised sounder 4500$^{\omega}$ works with a change of 20 volts; a polarised sounder 2000$^{\omega}$ with 10 volts. Given the conductor resistance of the line, we can say that on the depression of the out-office key the potential change at the head office condenser must be at least 20 volts.

We must now assume resultant conductor and insulation resistances of our hypothetical worst line. For the former 500$^{\omega}$ was taken, for the latter 2000$^{\omega}$, this being equal to the lowest permissible mileage insulation standard on a 100 mile line, or half that standard on a 50 mile line. Of course it will not be forgotten that the conductor resistance under perfect insulation conditions will be much higher.

Plotting the fall of potential at the head-office condenser, key up

Digitized by Google

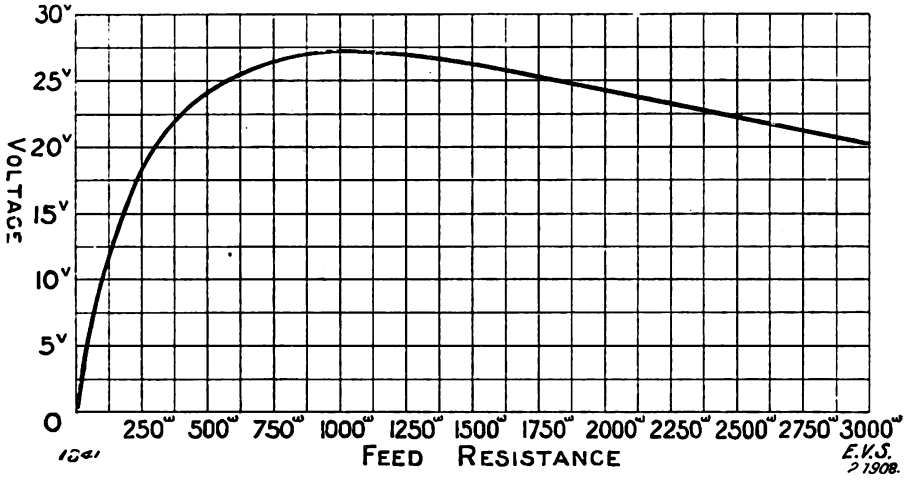
and key down at the out office, it is found that a feed of 1000ω gives the greatest margin.

Maintaining the insulation resistance at 2000ω the conductor resistance may rise to 750ω without the circuit failing. By using a 2000ω polarised sounder much greater margin is given.

Theoretically with a 750ω line and a 2000ω insulation resistance a feed resistance of 1200ω is best, but as the insulation resistance may fall still further and yet the circuit work with a lower feed than 1200ω, it will be seen that 1000ω is better.

Furthermore the graph 3 shows that feed resistances from 750ω to 1450ω give no great variation in efficiency.

Since the adoption of the 1000ω standard for feed resistances,



3.—Graph showing the Potential Changes at the Head Office Condenser with various Feed Resistances in use produced by the depression of the Out Office Key at the end of a line of 500ω Resultant Conductor Resistance with a Resultant Insulation Resistance equal to 200,000ω per mile on a 100-mile line.

attention has been given to the theoretical value of the best feed resistance by others, and Mr. H. H. Harrison, in 'Electrical Engineering' of March 17th, 1910, gave the following formula for finding its value :

$$f = \sqrt{Rc\ Ri};$$

Where f = feed resistance,
Rc = conductor resistance,
Ri = insulation resistance.

In actual practice this formula, although interesting, is not of such importance as at first might be supposed. It cannot be applied without taking into consideration other requirements.

If Ri be infinity, the law is obviously inapplicable. If Rc and Ri

Digitized by Google

approach each other in value, the feed value obtained may be quite useless, although the same feed for another combination of *Rc* and *Ri* may give a splendid circuit.

The relationship of *Ri* to *Rc* required for each receiving instrument in use is essential. The Department in selecting circuits for C.B. working adopts the standard that *Ri* should equal *Rc* × 3. Substituting in the formula we get $f = \sqrt{3Rc \times Rc} = 1{\cdot}7\ Rc$. But polarised relaying sounders will work with a much less change of potential than ordinary polarised sounders, and *Ri* only requires to be one and a half times *Rc*. Substituting again $f = \sqrt{1{\cdot}5\ Rc \times Ri} = 1{\cdot}2\ Rc$.

Another fact that causes us to keep the feed resistance as low as possible is—that the greater the feed resistance the lower the potential to line when the insulation resistance is low. Assume a feed of 4000$^{\omega}$ and an insulation resistance of 4000$^{\omega}$ with an 80^{v} battery, the potential at the head office condensers is 40^{v}, which drops to 7^{v} on the depression of an out office key 400$^{\omega}$ from the head office. Replace the 4000$^{\omega}$ feed by one of 1600$^{\omega}$ and we get a change from 57^{v} to 16^{v}, that is, 41 as against 33 volts.

Also the potential at the out office condensers is much higher with a low feed than with a high feed under the same line conditions above. Ignoring the conductor resistance of the line for a moment, we see that the potential at the out office condensers varied from 57^{v} to 40^{v} due entirely to the different value of feed. Working from the head office to the out office is therefore better.

The fourth point is: *That for circuits capable of working on the central battery principle, but which are the least suitable, a* 1000$^{\omega}$ *feed gives the best all-round results. This feed is also efficient for more suitable circuits.*

Polarised sounder.—The 4500$^{\omega}$ winding has given way to a 2000$^{\omega}$ winding. Although, owing to the difficulty of obtaining true values of *L* due to a condenser charge and discharge, it seemed impossible to prove mathematically what the best winding should be, it was felt that with 4500$^{\omega}$ the limit where the best magnetic effect was produced had been exceeded. A 2000$^{\omega}$ sounder was therefore experimented with, and the results were so satisfactory that it was decided at once to adopt it as the standard. It worked with a P.D. of 10^{v} as against 20^{v} for a 4500$^{\omega}$ winding. Of course a sounder may be designed that will work with a less change of potential, but in this country, where solitary circuits are very uncommon, it is not wise to carry the sensitive idea too far, for what is readily worked by its own small currents is also readily upset by foreign or extraneous currents.

Fifth point: *A* 2000$^{\omega}$ *sounder is more sensitive than a* 4500$^{\omega}$ *sounder, but its sensitiveness is practically the limit that can be*

Digitized by Google

advocated, owing to the necessity for a neutral adjustment and the danger from interference.

Condenser.—Condensers of various capacities were tried with the potential differences met with in practice, and the value that gave the uniformly best results with the polarised sounder of the pony pattern was 4 m.f. Condensers of 2 m.f. capacity under some conditions gave light and "shaky" signals due to an excess of *spacing* effect. Condensers of 8 m.f. capacity under some conditions gave heavy and running signals due to an excess of marking effect.

Sixth point: *A condenser of 4 m.f. capacity has been proved experimentally to be the most suitable one for central battery circuits.*

Digitized by Google

THE DETERMINATION OF STANDARD TIME BY WIRELESS TELEGRAPHY.

By Commandant FERRIÉ,
French Military Wireless Telegraph Service.

IN order to determine the longitude of a point on the surface of the earth, it is necessary to know the local time at the point in question and the time, at the same instant, on a standard meridian. Usually the meridian passing through Greenwich Observatory is taken as the standard.

Local time can easily be determined by astronomical observations, but up to a few years ago the only convenient method by which navigators and explorers could know Greenwich time was for them to carry one or more chronometers, set to standard time when leaving places, the longitude of which was accurately known, and carefully protected at considerable trouble from disturbing influences on the journey. But even the best chronometers are always slightly irregular, and it is also very easy, especially during a long overland journey, for them to be thrown out of correct time by slight accidents. Thus determinations of longitude are rendered inaccurate.

The invention of wireless telegraphy, however, has enabled the traveller to keep in direct communication with the land when at sea, or with civilisation when on a journey through an unexplored country. If a service be organised to indicate standard time by prearranged wireless signals, the chronometers can be checked frequently, and errors due to their variation avoided.

The French Government has studied the question of the provision of a system of time signals for this purpose, and Commandant Ferrié, one of the delegates to the recent Radio-telegraphic Conference in London, has kindly communicated to THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL the following short account of the methods which have been devised.

Digitized by Google

Twice every day, in the morning and the evening, the following series of signals is sent out by the Observatory of Paris, actuating, through relays, the large wireless station at the Eiffel Tower.

As regards the morning signals, at 10.40 a.m. the words "Observatoire de Paris" are transmitted.

At 10.44 a.m. a series of slow dashes is commenced, and continued till five seconds before 10.45 a.m.

Exactly at 10.45 a.m., Greenwich time, the standard clock of the Observatory closes the transmitting circuit at the Eiffel Tower for about a quarter of a second, and a rather long dot is sent.

At 10.46 a.m. a series of dashes separated from one another by two dots is commenced, and continued till five seconds before 10.47 a.m.

Exactly at 10.47 a.m. a dot is sent.

At 10.48 a.m. a series of dashes separated from one another by four dots is commenced, and continued till five seconds before 10.49 a.m.

Exactly at 10.49 a.m. a dot is sent.

Thus three time signals are sent—at 10.45 a.m., 10.47 a.m., and 10.49 a.m.

A similar series is sent in the evening, commencing at 11.40 p.m.

By noting the time indicated by a chronometer at the instant when the time dot is heard, it is easy, even for an inexperienced observer, to check the chronometer reading to within half a second. A practised observer can even check the reading to one tenth of a second.

Thus, for observers situated within the range of the Eiffel Tower, it is easy to obtain Greenwich time accurate to within half a second.

In the case of an observer situated at a place outside the range of the Eiffel Tower, or of some other observatory from which accurate time signals can be sent, the problem is more difficult. If, however, the place in question be within the range of a wireless telegraph station, and if, also within the range of this station, there be a place the longitude of which is accurately known, the longitude of the first place can be found. It is not necessary for the wireless telegraph station to be equipped with any apparatus beyond that used for signalling.

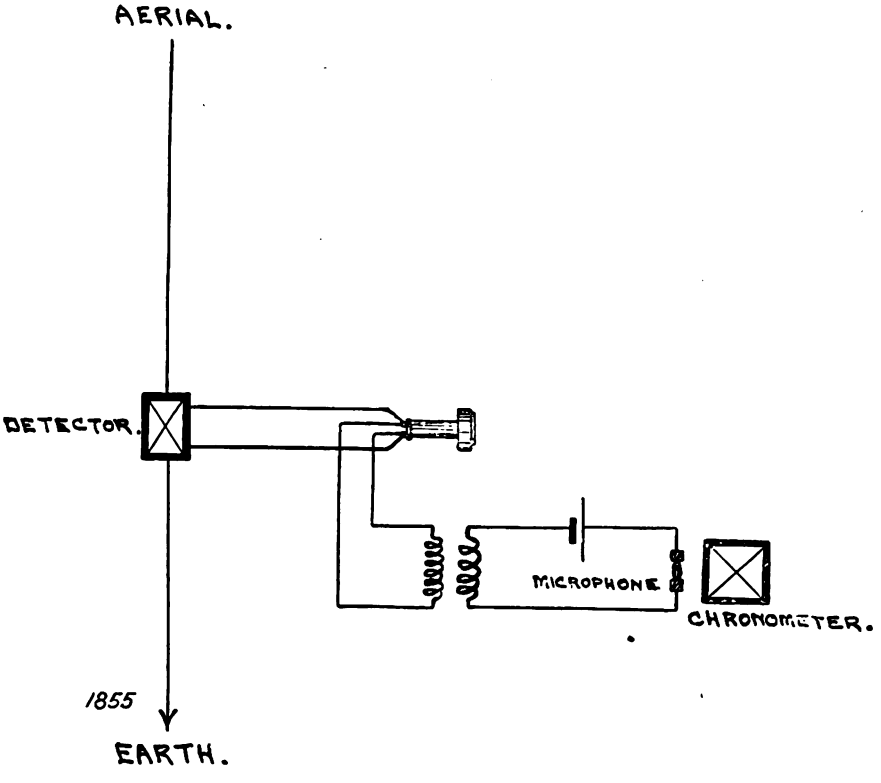
Receiving stations are installed, both at the place the longitude of which is required, and at that of which the longitude is known. The chronometers at these stations are set to local time, which is known accurately by astronomical observations.

When a set of longitude observations is to be made, the operator at the transmitting station sends out some agreed preliminary signals as a warning, and then, after a pause of a few seconds, sends a single dot. The receiving operators note the time indicated by their chronometers when this dot is received.

Digitized by Google

By a repetition of this process, using different preliminary signals to prevent confusion, as is done in the case of the Eiffel Tower time signals, several such pairs of chronometer readings for the same instant of time can be taken at the two stations.

In this manner the difference between the local times at the two stations is obtained. The difference between the local times gives at once the difference in longitude, and since the longitude of one of the stations is known, that of the other can be obtained.



I.—Connections for the Simultaneous Reception of Wireless Signals and Beats from Chronometer.

It is evident that by this method any number of places can simultaneously measure the difference between their local times and the local time of the place of known longitude, and this, of course, greatly expedites the accurate mapping of an unexplored tract of country.

The method of checking a chronometer by the reception of a definite time signal does not admit of an accuracy within one-tenth of a second. For very accurate observations, however, a much greater degree of refinement is essential. By the method about to

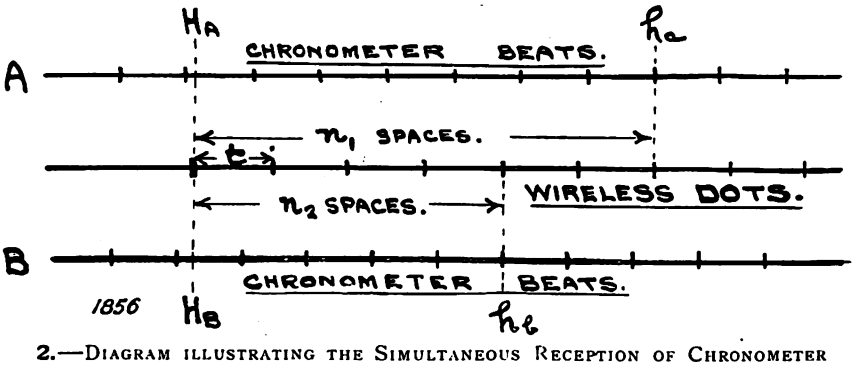
Digitized by Google

be described the correct time can be obtained to within one hundredth of a second.

As in the method already explained, the chronometers at the various stations concerned are set very accurately to local time by means of astronomical observations, and the problem is to observe these local times at some definite instant.

At the wireless transmitting station a pendulum is installed, adjusted to beat with a period slightly longer than one second. This pendulum is associated with the transmitting apparatus in such a manner that at each beat a dot is emitted.

At the receiving stations the apparatus is arranged as shown in 1. In addition to the ordinary receiving apparatus, a microphone is placed near the chronometer, and joined to the primary coil of a transformer and a battery. The secondary coil of this transformer is joined to the terminals of the receiving telephone.



2.—Diagram illustrating the Simultaneous Reception of Chronometer Beats and Wireless Dots.

Thus the beats of the chronometer are heard in the telephone at each station in addition to the signals emitted by the transmitting station.

Let the marks on the upper line in 2 represent the one-second beats of the chronometer at a station A, and the marks on the middle line represent the dots received from the pendulum at the transmitting station. Let t be the interval (somewhat greater than one second) between these dots. It is clear that since the intervals between the beats composing these two series of sounds are different, the beats will periodically come into exact, or, at least, very close coincidence, while between the points of coincidence the beats will be more or less out of step.

Suppose that coincidence occurs after $(n_1 + 1)$ dots (or n_1 spaces) have been received, and that the time indicated by the chronometer at station A is h_a. Then the time indicated by the chronometer at station A when the first of the series of dots was received was—

$$H_A = h_a - n_1 t.$$

Digitized by Google

It will be seen that the system just described is an application to time signals of the well-known principle of the vernier. The value of t can be obtained by noting the number of dots received between the times h_a' and h_a'' of two coincidences. If N be this number of dots, we have $h_a'' - h_a' = Nt$.

Thus $t = \frac{h_a'' - h_a'}{N}$.

In practice t is about 1·01 second.

Let the marks on the lower line in 2 represent the one-second beats of the chronometer at another station, B, and let coincidence occur after $(n_2 + 1)$ dots have been received, and at the time h_b indicated by the chronometer at B.

Then the local time at the station B when the first of the series of dots was received was $H_B = h_b - n_2 t$.

H_A and H_B are thus the local times at stations A and B at the same instant of time, the instant of the emission of the first dot of the series. Hence the difference in local time between these two stations is $H_A - H_B = h_a - h_b - (n_1 - n_2)\, t$.

In order to facilitate the counting of the dots, those corresponding to each complete minute are omitted. Coincidences occur about every minute, and each series of dots is continued for a sufficiently long time for several coincidences to be observed. A greater degree of accuracy is thus obtained.

Station A may be any one of those the positions of which have to be determined, while the position of station B is accurately known.

Thus, as explained above, the difference in longitude between the unknown stations and the known station is determined, and hence their absolute longitudes can be found.

EXTRACTS.

WIRELESS AT SEA.—It is reported from Berlin that new regulations will come into force on October 1st, according to which all German passenger steamers with a complement of 75 persons and upwards, inclusive of the crew, will be obliged to carry apparatus with a radius of at least 100 nautical miles. The same provision will apply to cargo vessels which regularly have more than 60 persons on board.—*Electrical Review.*

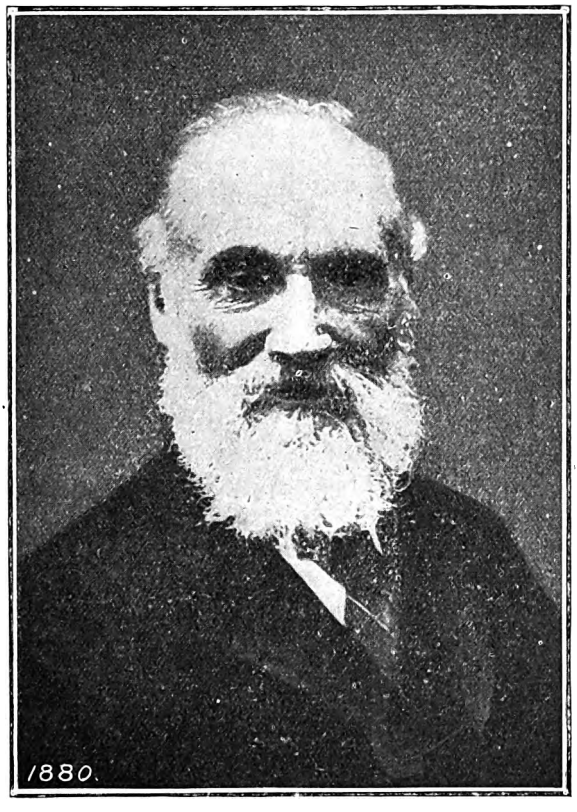
WIRELESS TELEPHONY.—Experiments recently carried out by the Italian naval and military authorities have resulted in the transmission of speech with clearness over a distance of 160 miles.—*Electrical Review.*

Digitized by Google

KELVIN.

By And. Fraser.

Six years ago, looking down from the gallery of the Natural History Museum at South Kensington upon the brilliant assemblage of men and women moving about beneath, the writer was struck by the manner in which groups of talkers would suddenly cease their



Lord Kelvin.

conversation and turn their eyes in the direction of an old, white-haired, white-bearded man, who, with a lady on his arm, was limping slowly up the grand staircase to meet at the top a young Japanese friend, with whom he engaged for a few minutes in animated conversation.

The man was William Thomson, of Glasgow, known to our day as Lord Kelvin of Largs, mathematician and physicist and Emeritus Professor of Natural Philosophy in Glasgow University, the man who made submarine telegraphy possible, and gave us measuring

Digitized by Google

instruments which for delicacy and accuracy have never been surpassed.

We have to go back to the year 1834 ere we come to the beginning of Kelvin's academic life, when at ten years of age he matriculated at Glasgow, studied there for six years and passed on to Cambridge without taking a degree. At the latter university he graduated second Wrangler and Smith's prizeman. His failure to obtain the coveted senior wranglership elicited from his tutor a query as to why he had spent so much time over a particular problem. Thomson's excuse was that he had to think it out from first principles. "But" said his coach, "it is a problem of your own discovery." Thomson had entirely forgotten it, and had to re-discover his own problem! From first to last Kelvin may be said to have been dominated by Fourier, whose book on the theory of heat was borrowed by him from the library, and mastered in a fortnight. From Fourier he gathered what became a conviction with him, that matter, as we know it, had a beginning in time. To give his own words when speaking of atoms, "They may have all been created as they were, complexity and all as they are now. But we know they have a past. Trace back the past, and one comes to a beginning—to a time zero, beyond which the values are impossible. It's all in Fourier."

Leaving Cambridge, Kelvin studied in Paris, under the great Regnault, who was then engaged in the determination of gas densities. To Kelvin, during his four months' instruction, was entrusted mainly the duty of working an air-pump!

In 1846, at the age of twenty-two, he became Professor of Natural Philosophy in Glasgow, and occupied the chair for the long period of fifty years.

In the year 1847 Kelvin met at the British Association a Manchester brewer, with whom he was to form a life-long friendship. This was Joule, whose investigations into the mechanical equivalence of heat were practically laughed at by the scientists of his day. With the aid of Thomson, however, interest in the new theory was stimulated, and to-day there is probably no student of electricity and magnetism who does not know the meaning of "J."

Passing on, we come to the year 1853, when Thomson delivered to the Glasgow Philosophical Society a paper on "Transient Electric Currents." This paper was a mathematical investigation into the discharge of a Leyden jar in a circuit under given conditions. Taking the equation for the energy of the jar as a starting-point and giving the discharge circuit inductance capacity and resistance, he built up a differential equation the integral of which indicated that so long as the resistance was greater than $\sqrt{\frac{4L}{K}}$ (where L and K

Digitized by Google

stand for inductance and capacity respectively), the discharge was in one direction only. If, however, it is less, the discharge is oscillatory; $R = \sqrt{\frac{4L}{K}}$ being the limiting value for oscillatory discharges.

In 1856 the preliminary steps were taken for the laying of a submarine cable which would connect Europe and America telegraphically, and Thomson found himself associated with a Dr. Whitehouse as the electricians of the new venture. Throughout the laying of the cable all continuity and insulation tests were taken by Thomson's own mirror galvanometer and using a battery of 75 Daniell cells. When the cable was handed over to Whitehouse, he promptly dismantled all Thomson's apparatus and replaced them by his own.

From this point communication became next to impossible—a result not surprising when it is borne in mind that signals were being sent into the cable from an induction coil having a P.D. of 2000 volts! After something like 700 messages had been transmitted the insulation gave way, and the great cable from which so much was expected, on which so much thought and time and care and money had been expended, was abandoned.

The spirit of enterprise, however, was not dead, and the year 1866 saw the successful laying of an Atlantic cable and Thomson's knighthood for the work he had done.

It would be impossible within the limits of this paper to enumerate the many contributions he made to science about this time, such as theories on the constitution of the ether; the connection between energy and electro-magnetism; our present system of electrical units and the construction of instruments for their measurement, etc., all of which bear the stamp of his marvellous individuality, for he seemed to be several personalities combined into one. In 1892 he was created Baron Kelvin of Largs. Four years later he celebrated his jubilee as a professor and retired from his duties in 1899. In December, 1907, he caught a chill, from which he never recovered. He died on the 17th day of the month, and on the 23rd was buried in Westminster Abbey with every tribute which a nation in mourning could bestow.

Looking back over a life like Kelvin's, one is at a loss to know where to begin when singling out special traits which would convey an adequate idea of the personality behind it. Yet these exist in abundance. The activity of his mind appeared to know no rest, and moments of apparent abstraction were really filled with some inward speculation or other. Munro tells that while walking with him one day Kelvin stopped abruptly to gaze for a moment at a mud ripple which had caught his eye in the street, and then passed

Digitized by Google

on. "Probably it appealed to him," says Munro, "as an experiment on the motion of glaciers and other viscous bodies."

In his class few of his students could follow his extraordinary methods of teaching—extraordinary in the sense that he would fly from one subject to another entirely disconnected from it, such as when lecturing on "moments," and illustrating his remarks by swinging a gas bracket backwards and forwards, he would end up with a dissertation on the inferiority of Glasgow's gas!

In his laboratory methods he was equally original, and Sir William Ramsay records that the first laboratory exercise given him by Kelvin was the disentangling of a coil of copper wire, which occupied him more than a week!

One day, whilst busy with some pianoforte wire in connection with his deep-sea sounding apparatus, he received a visit from his friend Joule, who, hearing the musical jangling of the wire, asked Kelvin what note he was sounding. "The deep C," was the reply! Kelvin gave us a name for the unit of conductivity, which, to use his own words, could be got if we "take a phonograph and turn it backwards and see what it will make of the word 'ohm.'"

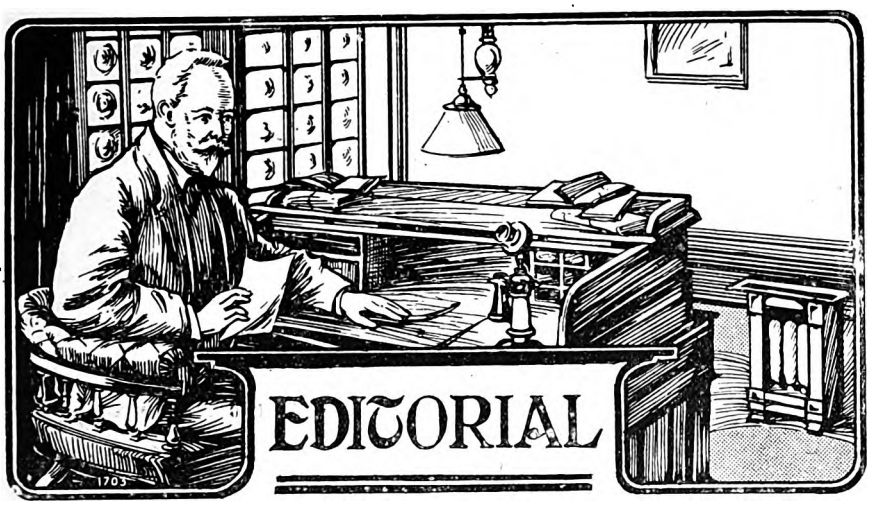
A man of strong convictions, he was not easily moved to abandon an existing or accept a new hypothesis unless he were absolutely sure as to its validity. Thus he never really gave his allegiance to Maxwell's theory as to the identity of light and electricity, although he has left us one of the classic determinations of "*v*." He also limited the age of the earth to lie between twenty millions and four hundred millions of years, and thus fell foul of the geologists, who wanted many more years than the latter for their purpose. But his pet theory was that of the nature of atoms and of molecules generally. He resuscitated the old discarded theory of vortices propounded by the great Descartes, and showed that a vortex once established in a frictionless fluid must continue for ever.

And here we leave the great student, for he liked to be regarded as a student, to whose fertile mind and indefatigable energies the world owes so immeasurable a debt to-day.

With Kelvin finishes this series of short biographies. Starting with Thales, who gave to the world of those far-off days theories of matter and electricity which led us to speculate as to whether we, in our day, had any better explanations to offer, we turn to Kelvin for guidance, and what do we find?

"One word characterises the most strenuous of the efforts for the advancement of science that I have made perseveringly during fifty-five years—that word is *Failure*. I know no more of electric and magnetic force, or of the relation between ether and electricity and ponderable matter or of chemical affinity than I knew and tried to teach my students fifty years ago."

Digitized by Google



AUTOMATIC EXCHANGES.—We are pleased to be able to present our readers with the articles and notes on the automatic telephone exchange system, which this number contains. It is unnecessary to dwell upon the importance of the subject, or to urge upon Post Office engineers the desirability of every opportunity being taken to familiarise themselves with the principles and details of the *coming* system of local exchange telephony. The leading principles and the general methods adopted are now becoming well known to most of us, but an intelligent professional grasp of the subject can only be obtained by much study of details. The question involves the whole range of telephone engineering—mechanical construction of complex apparatus, schemes of electrical connections and control circuits, and the provision and economic disposition of junction circuits to other exchanges, and among the different orders of selectors, so as to carry the traffic without either introducing waste of plant or hampering the service through inadequate provision of outlet circuits at any point. All this means study on a wide and comprehensive basis.

Mr. Callender's article describing the recent change-over to automatic working at Epsom, will be read with interest. The change appears to have been made with smoothness and success, and one is glad to hear that the subscribers have, as a whole, taken kindly to the new method, and are operating the automatic calling devices satisfactorily. The case of Epsom is not really a good one from the traffic point of view. Lying on the fringe of the London area, there is a high percentage of junction traffic to neighbouring manual exchanges, and the proportion of local calls that can be completely effected through the automatic medium is therefore small. The Epsom subscribers might be forgiven a certain amount of irritation

Digitized by Google

on account of the fact that so far as the bulk of their calls are concerned, the manipulation of the dial switch has to be undertaken as a wholly additional operation, after which the number of the party required has still to be passed, *viva voce*, to an operator in the old way before the desired connection can be obtained. For that reason we are glad to hear that the proposal to instal another small automatic system at the Caterham Valley exchange has been dropped, and that the apparatus which has been manufactured for the purpose will be fitted up at Hereford, instead of at Caterham. At Hereford the proportion of calls local to the exchange is very high, and the results will be much more satisfactory from the standpoint of the public than would have been the case at Caterham. The system at Hereford will be that known as the "Lorimer." This system differs greatly from the well-known "Strowger" system, and its use so far has been confined to a few comparatively small exchanges in Ontario and one exchange in France. We have not yet been able to place a description of this system before our readers, but hope to do so in the near future. A comparison of its details with those of the more familiar Strowger system is interesting, as showing how the same problem, approached in different ways, is capable of very different solutions. In the Lorimer system the motive power is not furnished by the direct action of electro-magnets energised by the signalling impulses, but mechanical power for operating the whole exchange is supplied by a continuously driven motor, coupled to a series of horizontal and vertical shafts and gear wheels on each apparatus rack, the whole of which are maintained in continuous and uniform motion. The necessary movement is imparted to the various switching devices by clutches of a simple type, which engage and disengage the rotating members of the switches with the running gear under the control of the signalling currents. The place of the line switches in the Strowger system is taken by call finders, known as "decimal indicators," each of which is provided with rings of segments connected to 100 subscribers' lines. A cage carrying contact brushes rotates once in three seconds around the segments, and continues to revolve uninterruptedly so long as no one of the lines connected is calling. When, however, one of the subscribers has called the exchange an earth connection is made at his telephone, and the brushes are arrested on reaching the corresponding segments. Subsidiary brushes complete the circuits of other switches, which locate the calling line on multipled tags and start the selecting switches. After this momentary pause, the brushes of the decimal indicator move on once more, and take up their continuous search for calling lines.

An interesting point in the construction of the switches is that they consist of complete rings of tags embedded in a plaster cylinder.

Digitized by Google

The multipled circuits are connected to the outer ends of the tags. The selecting brushes or wipers are placed within the cylinder, and in all cases return to zero by completing the circle. The subscribers' telephones are not equipped with the well-known finger dial impulse senders, but the call is set up visibly by means of a series of 10-step levers. After setting up the number wanted, the subscriber turns a tripping handle which winds up a spring and starts the mechanism, controlling reverting signalling impulses which are sent back from the exchange switches to the calling telephone.

The respective advantages of the Lorimer and Strowger methods of calling must be weighed to a considerable extent from the standpoint of the public user, and this is one of the interesting points which the installation of the proposed Lorimer installation at Hereford will help to decide.

Mr. Bailey has made a magnificent effort to provide an absolutely up-to-date and comprehensive technical description of the Strowger system, and we feel sure our readers will join with the Board of Editors in thanking him. All who have attempted to do so have realised the difficulty of getting a grasp of the complex automatic circuits, and they will welcome Mr. Bailey's explanations and valuable diagrams.

Mr. Lawson, who deals with the historical side of the subject, is the author of an Institution of Post Office Electrical Engineers paper on automatic telephony, which has been much in request since the subject recently became so prominent.

Mr. E. A. Laidlaw, who has furnished a series of facts on the economy of automatic telephony, was until recently one of the experts of the National Telephone Company. Narrowly escaping the Civil Service fate which has overtaken so many of his colleagues he has joined Messrs. Siemens Brothers, and is devoting all his abundant energy to the development of their particular type of automatic, which is making rapid headway in Germany and elsewhere on the Continent.

THE TRANSFER ARBITRATION.—To leave the brilliant sunlit Strand for the cool recesses of the stone-built Law Courts on June 10th, and to see there reconstituted so faithfully the scenes of May, June and July of last year, tended to make one feel that time had stood still. Again we found ourselves in King's Bench Court No. 9, a sort of enlarged cell about 30 ft. square. Along one side the Railway Commissioners, the Hon. Gathorne-Hardy, Mr. Justice A. T. Lawrence—made imposing by wig and gown—in the centre, and Sir James Woodhouse on the right. In front of these the Clerk of the Court, also in wig and gown, entrenched behind rows of ponderous legal tomes; on his left hand, under the witness box, a considerable

Digitized by Google

assembly of press-men ; facing these, and filling the remainder of the Court we have the pew-like benches which give accommodation to the principals in the drama, arranged exactly as last year, Post Office people on the Judge's right hand, National Telephone Co.'s people on the Judge's left hand. In the front row, commencing from the middle, we have, for the Post Office, Sir John Gavey, Sir Robert Hunter, Mr. J. F. Ç. Snell, and the Engineer-in-Chief, Mr. W. Slingo, supported by Messrs. DeLattre and Martin in the Jury box. On the other side, commencing again from the middle, we have Mr. Gill, Engineer-in-Chief to the Company, Mr. Hart, the Company's Solicitor, Mr. James Swinburne, and Mr. Franklin, the President. In the next row we have the big guns of the legal profession, Sir John Simon and Sir Rufus Isaacs (for the Post Office) on the one side, Sir Alfred Cripps and Mr. Danckwerts (for the Company) on the other. Behind these came, for the Post Office, Mr. Buckmaster, Mr. Rowlatt, and Mr. Branson, and on the other side Mr. Forbes Lankester, Mr. Morten, Mr. Gaine, and Mr. Lawrence. In other parts of the Court we see Messrs. Ogilvie, Horne, Preston, Wissenden, Hooke, Johnson, Carr, and the Controller of Stores, Mr. Morgan, of the Post Office, supported by Mr. Preece. Flanking these we have for the Company Mr. Goddard, Mr. Cook, Mr. Clay, Mr. Albert Anns, Mr. Watts, Mr. France, Mr. Aitken, Mr. Fletcher, together with Sir Alexander Kennedy.

Sir A. Cripps rises to address the Court. After a few minutes Sir Rufus Isaacs departs and we are once more hearing the history of the English Telephone service. The illusion is complete; we feel that we have been here since May, 1911, and we wonder in a curious semi-conscious sort of way whether we shall still be here in June, 1913.

We do not propose to inflict on our readers a verbatim report of the proceedings because several volumes would not provide the space necessary, and probably most of our readers are much too busy to find time to read them. We shall content ourselves by reporting any vital decision as soon as one has been arrived at. We go to press immediately after the opening of the case.

MARCONI'S WIRELESS TELEGRAPH COMPANY.—The directors of Marconi's Wireless Telegraph Company have issued a circular to their shareholders, which gives much interesting information as to the progress of wireless telegraphy.

Satisfactory terms have been settled between His Majesty's Postmaster-General and the Company for the construction of all the long-distance wireless stations which will be required within the next few years for the Imperial Wireless Scheme.

All the stations to be erected under this Imperial scheme will be fitted with the latest duplex invention of Mr. Marconi, and also with

Digitized by Google

apparatus for automatic transmission and reception, under which conditions the Company guarantees a speed of not less than fifty words per minute, which under favourable conditions should be considerably exceeded.

All the long-distance commercial stations which the Company will be erecting in the future will be fitted with similar apparatus for automatic transmission and reception.

The acquisition of the patents of the Lodge-Muirhead Syndicate has strengthened the Company's patent position.

In October last the control of the Russian Company of Wireless Telegraphs and Telephones was acquired. This Company possesses extensive freehold works in St. Petersburg.

The Compania Nacional de Telegrafia sin Hilos has completed its first chain of stations, and a further number will be erected as soon as the Spanish Government have approved of the sites selected. A considerable telegraph business is being conducted between Spain and the Canary Islands, and also with ships at sea. As soon as the necessary arrangements will have been completed, it is intended to open up the service between the Canary Islands, Spain and this country, and further extensions of the service will follow.

Recently the Chairman and Managing Director paid a visit to Madrid, and were received in private audience by His Majesty the King. His Majesty bestowed the honour of the Grand Cross of the Order of Alfonso XII upon Mr. Marconi.

Progress of the greatest importance has been made in the United States of America. For some years past the American Company was able to transact but a comparatively small business owing to the severe competition to which it was submitted by the United Wireless Telegraph Company. The business methods adopted by that Company were such as to render effective competition impossible unless business were to be conducted at a substantial loss.

There was, however, no doubt that the United Wireless Company was infringing the patents of this Company, and proceedings at law were therefore commenced. The Chairman and Managing Director proceeded to New York accompanied by Mr. James Swinburne, F.R.S., to give evidence on behalf of the American Company, the case having been fixed by the judge to be heard on March 25th.

Following the prosecution and subsequent conviction of the Directors of the United Wireless Telegraph Company the business was being conducted by trustees under the Court, pending the completion of the arrangements which were in course by a shareholder's re-organisation committee.

As a result of negotiations between the trustees, the shareholder's committee and the Company, agreements were eventually

Digitized by Google

entered into by which the Company acquired the whole of the tangible assets both in and out of the United States of the United Wireless Telegraph Company. These assets in so far as they related to the United States of America were re-sold to the Marconi Wireless Telegraph Company of America.

The United Wireless Telegraph Company acknowledging the validity of the Marconi patents, and admitting the infringement, judgment and a perpetual injunction were granted by the Court.

The business is now being directed by the Marconi Wireless Telegraph Company of America, and for their account as and from March 31st last. Arrangements are in progress for the transfer to this Company of the property out of the United States of America possessed by the United Wireless Telegraph Company, and judgment by consent in favour of this Company will be taken in the actions pending against the United Wireless Telegraph Company in our High Courts of Justice.

The satisfactory ending of this litigation together with the acquisition of the tangible assets of the United Wireless Telegraph Company is of the greatest importance. It converts the business into one of considerable magnitude, controlling all the coast stations of importance on both the east and west coasts, besides practically the whole of the American Mercantile Marine at present fitted with wireless telegraphic installations. A considerable impetus, however, to the ship and shore business in the United States is to be expected from recent events by the extension of the scope of the existing law rendering wireless telegraphy compulsory upon practically all vessels.

A further agreement of great significance and importance has been entered into with the Western Union Telegraph Company and the Great North-Western Telegraph Company.

This agreement *inter alia* furnishes the Marconi Company with some twenty-five thousand telegraph stations for the delivery and despatch of Marconigrams throughout the United States and Canada. It is no doubt well known to our readers that in the United States of America the telegraph service is not carried on by the Government as is the case in other countries, but is in the hands of private companies, mainly of the Western Union Telegraph Company, with whom also is associated the telephone service.

The American continent represents a very important proportion of the telegraph business of the world, and therefore a considerable link in the chain of stations round the world which forms the more important programme of the future of this Company. In order to create an efficient telegraph service it was essential to this Company either to have the benefit of such an immense organisation as that of the Western Union for the purpose of the receipt and delivery of

Digitized by Google

its messages, or to itself create an opposition service. One or the other was necessary before it would be possible effectively to create long-distance services between this country and New York, the Pacific coast and the East, and between North and South America. The agreement now entered into enables this Company in conjunction with the America Company immediately to embark upon the erection of the stations which will open up by wireless improved and cheaper telegraph services to all these parts of the world, fulfilling an important section of this Company's programme.

Arrangements are now in progress, and the work will be carried out as expeditiously as possible, for the construction of stations placing this country in direct communication with New York, instead of as at present passing through the station at Glace Bay, for the construction of stations at San Francisco, communicating through the Hawaiian Islands to the Phillippines, China and Japan, and from New York south to Cuba, Panama, and subsequently with each of the South American States.

The United States having now adhered to the International Radio-telegraphic Convention, the conduct of business will be greatly facilitated, and irresponsible and troublesome interference caused by amateurs and others in the past will now cease.

The Coltano (Italy) long-distance station was opened in December of last year, and is working most satisfactorily with the Italian Colonies on the East Coast of Africa.

The Transatlantic service has continued to work satisfactorily. From May 1st of this year all the postal telegraph offices throughout the United Kingdom have been opened for the reception of messages "*via* Marconi" to any part of the United States of America and Canada. The Company has now the use of a private line from eight at night until eight in the morning, by which it is able to send its messages directly from its office in the Strand to the Clifden Station, thus materially curtailing the delays which occur on the land lines. It is hoped that the use of a private line in the daytime will be obtained shortly. There has been a considerable increase in the number of commercial messages and in press work, many thousands of words being despatched every day from London to the New York press.

The general public are now beginning to realise that it can send its messages to America and Canada by wireless at 4*d.* per word less than by other systems. When the land lines were clear the 'New York Times' received in their office in New York messages sent over our system from London within ten minutes of the time of their despatch. When the new stations between London and New York are complete they will be independent of the land lines, and will provide a service which will not be surpassed in speed or accuracy.

Digitized by Google

The successful development of the Company has not unnaturally brought into prominence a large number of inventions and patents in connection with wireless telegraphy, most of which, if not all, are first offered to the Marconi Company. A staff of able engineers under the direction of Mr. Marconi are employed in examining carefully every patent specification which has any connection with wireless telegraphy, and a practical test is made of every device or system for which patent application is made, or which is submitted to this office.

The Company makes a point of keeping itself very well informed in these matters, and is at all times prepared to pay reasonably for anything new and of value which comes to its notice.

It has entered into arrangements by which it obtains the sole rights of the world of a process invented by Messrs. Bellini and Tosi and which is known as the wireless compass. This is an invention which, with certain improvements introduced by the Company's engineers, should prove to be of considerable value. It will be worked in conjunction with existing wireless telegraphic installations on board ships, and will define the position of an approaching ship or of land in a dense fog, thus eliminating a further danger, and perhaps one of the greatest to which navigation is subjected. Active steps are now being taken for the commercial development of this process.

The recent terrible catastrophe upon the Atlantic Ocean has again brought prominently before the notice of peoples of all nationalities the immense value of Mr. Marconi's invention, and the necessity of its more general use by ships at sea. Whether or not wireless telegraphy should have saved every soul on board the "Titanic" will probably be known when the Board of Trade inquiry will have been concluded. In the meantime, however, it is but reasonable to suppose that a number of vessels could have been called to assistance had they had a wireless installation on board, and therefore have been capable of receiving the terrible news instead of continuing on their way ignorant of the tragedy which was taking place within perhaps a short distance of them. There can be little doubt that this terrible catastrophe brings us nearer to the day when ships of every nation will be compelled to carry this greatest life-saving apparatus.

It may not be out of place here to refer to the prevalent ideas of which one has heard so much in recent times respecting the so-called tapping of wireless messages. Under the Berlin Convention of 1906, it was agreed by all the nations who are adherents to that convention that ships at sea must be at attention on a wave-length of 300 metres, and that conversations between ships at sea and coast stations shall be carried on by the use of wave-lengths of either 300 or 600 metres. The very object of this international law is that in case

Digitized by Google

of distress or otherwise, every ship at sea shall be capable of calling or being called by any other ship at sea or any coast station; thus every ship is necessarily able to overhear any other vessel or station within range. This, however, applies to ship communications only. Mr. Marconi's famous No. 7777 patent enables stations to tune to any wave-length by simple means, and only stations tuned to the same wave-length can communicate together.

The Marconigraph magazine, which was started by the Company in the early part of last year, has now developed into an important publication with a continuously increasing circulation.

JOHN MURRAY CRAWFORD: AN APPRECIATION.—The hearty congratulations of all grades of Post Office Engineers are extended to Mr. J. M. Crawford on his appointment to the responsible position of Assistant Electrical Engineer in the Postmaster-General's Department of the Australian Commonwealth.

Although the home service will be the poorer through the withdrawal of one of its most efficient engineers, it will be agreed that the selection confers honour upon the engineers of the British Post Office service. It is understood that the total number of applications for the post approached 300, and it speaks well for the prestige of the service to record that, in order to make the final choice, three Post Office engineers were selected.

For many years Mr. Crawford has laboured with zeal and steadfastness of purpose for the good of his colleagues, and the removal of his strong personality and influence from the different service organisations with which he has been associated will be a cause for genuine regret.

Mr. Crawford's name will be remembered as one of the founders of the Society of Post Office Engineers; he represented his colleagues with conspicuous ability as a witness before the Hobhouse Commission, whilst on numerous occasions he has taken a leading part in deputations and interviews on behalf of the Staff. As a member of the Executive Committee, also as Honorary Treasurer of the same Society, he has done splendid work.

Mr. Crawford was a member of the Formation Committee of the Institution of Post Office Electrical Engineers, he has held office as General Secretary of the Institution for two years, whilst from its foundation he has been selected by his fellows to represent their interests as a member of Council.

In his work as Chairman of the Post Office Defence Committee, Mr. Crawford has been closely engaged for a long period in an endeavour to safeguard the interests of all Post Office employees in the difficult problems attending the transfer of the staff of the late National Telephone Company, and he has done everything possible

Digitized by Google

to ensure that the combination of the respective staffs shall be effected on an equitable basis.

In the discharge of his duties as a member of the Board of Editors of this Journal he has done excellent work, and his colleagues on the Editorial Staff cannot allow this opportunity to pass without marking their sense of appreciation.

The wider field of public work has claimed Mr. Crawford's services for many years; he is a man of strong religious convictions with pronounced views on temperance and other social reforms, and in each of these departments he has adopted a definite line of action which commands admiration and respect.

The writer has had the privilege of intimate friendship with John Crawford since boyhood—from the old days at "LV," when thoughts were fixed on the delights of outdoor games rather than on the outlook in the Engineering Department. Even in those youthful days John was marked out by his fellows as a character to be reckoned with. He is essentially a man of strong moral courage with an unflinching sense of duty, and it matters little to him whether the cause he has in hand is popular or otherwise, or whether he has to fight his way singly against great odds. If the cause is a good one he sticks to it and invariably "wins through."

The Department can ill afford to spare such a man from its service; his colleagues also will find it difficult to replace him in the many spheres of action in which his talents have been employed. We are sorry indeed to lose his services at this important juncture in the history of the Engineering Department, and in wishing him adieu we would thank him for all that he has accomplished, also for the example he has given to his fellows in his interpretation of the ideals of true citizenship.

It will be the earnest wish of every Post Office Engineer that Mrs. Crawford's health, which has given cause for anxiety in the past months, will be completely restored during her sojourn at Melbourne, also that we may receive at very regular and frequent intervals contributions to the JOURNAL from "Our Own Colonial Correspondent."

A. O. G.

LOCAL CENTRE NOTES.

SOUTH WALES CENTRE.

The closing meeting of the Session was held on Tuesday, March 12th, when Mr. J. F. McMullen read a paper on the "Barry New Telephone Exchange," which was illustrated with a series of lantern-slides and diagrams. The Barry equipment constitutes a departure from the type of switchboard hitherto installed in South Wales, and

Digitized by Google

the paper was of special interest to the members and visitors who were present.

The meeting concluded with a vote of thanks to the President, Mr. R. McIlroy, for the able and kindly manner in which he had conducted the meetings and the affairs of the Institution generally during the Session.

Our thanks are again due to the Council of the South Wales Institute of Engineers for the privilege of holding our meetings in their handsome premises at Park Place, Cardiff.

NORTH-WESTERN CENTRE.

The inaugural meeting of the New North-Western Centre was held at Preston on March 18th, 1912, Mr. T. E. P. Stretche (Superintending Engineer) presiding over a good attendance of members.

The result of the ballot for the officers of the local organisation was declared, and the following gentlemen were formally elected:

Committee: Messrs. Cunningham, Field, Leggett, and Savory.

Librarian: Mr. A. J. Ross.

Secretary: Mr. D. Barratt.

The future of the Centre was discussed at some length, and numerous suggestions for enhancing its usefulness were forthcoming, whilst actual promises of contributions to the programme for the ensuing session were made by several of the members present.

The meeting concluded with a hearty vote of thanks to Mr. J. Cooke, who had kindly acted in the capacity of Hon. Secretary *pro tem.*

A highly successful dinner, followed by a smoking concert, was held at the Crown Hotel, Preston, on March 18th, 1912, when about seventy sat down to an excellent repast.

Mr. T. E. P. Stretche (Superintending Engineer) occupied the chair, supported by Mr. J. W. Sullivan (Assistant Superintending Engineer), and amongst the visitors present were Alderman N. Miller, J.P. (ex-Mayor of Preston), Mr. F. Oldfield (Postmaster, Preston), and Mr. W. Soothill, of the Accountant-General's Department.

The loyal toast having been duly honoured, that of the visitors, proposed in eloquent terms by Mr. J. W. Sullivan and drunk with musical honours, was suitably responded to by Messrs. Oldfield and Soothill.

The toast of the chairman was proposed, with musical honours, by Mr. F. W. Best, Executive Engineer, Oldham. The chairman, on rising, was received with acclamation, and in replying spoke of the loyal manner in which the staff had supported him during the trying period which must necessarily follow the inauguration of a new district, and congratulated them upon the success which had attended their efforts. The remainder of the evening was devoted to

Digitized by Google

harmony, a capital musical programme having been arranged, to which several members of the staff contributed.

The proceedings were brought to a close with the National Anthem, and the hope was freely expressed that the event might become an annual one.

The arrangements were in the hands of Messrs. Cooke, Barratt, Powley, and Ross, the first-named acting as Secretary.

EASTERN CENTRE.

At the fifth meeting of the Session, which took place at Cambridge on the afternoon of Tuesday, March 5th, a paper was read by Mr. H. A. McInnes, entitled, "Notes on the Work of Remodelling the Irish Line, Rickmansworth to Broadway, Worcestershire."

Mr. McInnes, in his opening remarks, detailed the various proposals which had been considered with a view to providing the additional accommodation required for trunk circuits on the Irish Line. These included the suggestion that the American practice of erecting such wires on the straight and crossing over in horizontal pairs at pre-arranged points should be adopted. It was explained that finally it was decided that the two outer pairs on either side of six-way arms should be revolved in accordance with the British P.O. practice, and that the centre pairs should be run on the straight and crossed over at intervals on the American principle, the vertical distance between the arms to remain twelve inches. Particulars of the rearrangement of the Irish and West Coast Lines to obtain the shortest route for telephone trunks were next given and the results of the preliminary speaking tests outlined.

The paper, which was illustrated by lantern-slides prepared by Mr. McInnes, concluded with illustrations and brief notes of American aërial construction methods.

The final meeting of the Session took place on the afternoon of Tuesday, April 2nd, when two papers were read, one by Mr. J. F. Lamb on "Commutation Poles and Sparkless Commutation," and one by Mr. G. W. Franklin entitled "Estimates (New Accounting System)."

Mr. Lamb commenced his paper with a brief description of the principles of commutation, illustrated by means of diagrams. The ordinary method of adjusting the brushes to suit variations in the load was described, and this was followed by some remarks on the theory and function of commutation poles. Design and method of winding were next dealt with and the effect of commutation poles on the field of a machine explained, the paper concluding with a mention of various points to be observed in the working of commutation pole machines.

Mr. Franklin, in dealing with the subject of "Estimates (New

Digitized by Google

Accounting System)," emphasised the importance of estimating duties, and the need for the careful consideration of proposals with a view to economy as well as efficiency. The alterations resulting from the introduction of the new accounting system were outlined. Following this, the process of checking and the preparation of estimates for Headquarters were described and the use of the various forms explained. The theory of the new system was next discussed, with special reference to the requirements as to the "estimated replacement cost as new" of displaced plant. The principles of ordinary commercial accounting and the applicability of those principles to the Department were next reviewed, the lecture concluding with a comparison between the old and new accounting systems.

Both meetings were well attended, and the reading of the papers was in each case followed by an interesting and profitable discussion.

LIBRARY NOTES.

THE following work has been added to the Library and is available for issue to members:

'Telephony.' S. G. McMeen and K. B. Miller.

TELEGRAPHISTS' SCHOOL OF SCIENCE.

REUNION OF OLD STUDENTS AND COMPLIMENTARY DINNER TO MR. SLINGO.

OLD students of the Telegraphists' School of Science, which for a number of years was carried on at the Central Telegraph Office, assembled at the Connaught Rooms, Kingsway, on April 20th, to do honour to the late Principal, Mr. Slingo, on his appointment to the high position of Engineer-in-Chief to the Post Office. The idea of having such a gathering spontaneously generated in many old students' heads or hearts, and was taken up most enthusiastically by officers in the Central Telegraph Office, Stores Department, Relay Stations, and the Engineering Department. A strong committee was formed, with Mr. H. North as Secretary, and the success of the dinner was never in doubt. About 150 old students, both ladies and gentlemen, and friends sat down to an excellent dinner, Mr. G. F. Mansbridge being in the chair, with Messrs. A. Brooker, A. W. Martin, J. E. Taylor, E. H. Shaughnessey and H. A. Miles at the heads of the various tables. An attractive musical programme had been arranged, but it is feared that it did not command the attention it deserved, and on this account alone it can be said that this was a most unusual dinner in that the audience actually preferred the speeches to music.

Digitized by Google

It is only a great reputation and a life full of endeavour which can stand analysis in the open by eight or ten speakers without any slackening of the interest of the audience, and in fact a desire for more. Mr. Slingo's career and its influence was dealt with from every point of view. Mr. McEwan told us with emphasis and hearty enjoyment of the early days in T.S. One gathered that the satisfying of healthy appetites played an important part in the every-day life of Mr. McEwan and Mr. Slingo. Science books in the "port" pocket balanced by apples in the "starboard" pocket was the ballast favoured by the future Engineer-in-Chief. Mr. McEwan was so full of his subject that it cannot be said that he finished his speech. He simply retired "not out," after having scored many boundaries and without making a mistake.

The Chairman (Mr. Mansbridge) and Messrs. J. E. Taylor and H. A. Miles dwelt more particularly on the work Mr. Slingo had done for the cause of technical education. It was pointed out that Mr. Slingo was one of the pioneers of the movement, and that apart altogether from the Telegraphists' School of Science he had started schools for the teaching of science at a time when the idea of developing such schools was only being mooted as desirable.

Stress was laid on the work Mr. Slingo had done in pointing the way and training men to occupy higher positions, and most of those present were indebted to Mr. Slingo on that account.

Mr. Martin's tribute to Mr. Slingo's clearness and power as a lecturer was warmly endorsed by the old students. Mr. Martin could only recall one other lecturer (Sir Arthur Rücker) who equalled Mr. Slingo in his gift of conveying knowledge to his hearers with such ease and in a manner to keep the interest at all times.

Mr. Jayne added his tribute on behalf of the staff at T.S. This speech, although containing much humour, was one that gave considerable food for thought. Mr. Jayne pointed out that the majority of those present served their apprenticeships in T.S., and that now they held high positions in the Engineering Department and other branches, and filled them with credit to themselves and the Department. Changes of policy had, however, practically cut off the possibility of following such a career for the men now in T.S., although he submitted with all deference there were probably men there equal in capabilities to those who had risen. He earnestly hoped that the time had not gone by in which a T.S. man could hope to be some day Engineer-in-Chief.

Mr. Newlands, Controller, Central Telegraph Office, although not on the list of speakers, made on admirable speech. Some of his epigrams on ability and favouritism were excellent. He added his tribute to the merits of Mr. Slingo, and incidentally told in proper style two or three humorous stories. Mr. Newlands' personality—

Digitized by Google

to which nervousness must be a stranger—did not permit him, however, to do justice to the man who stuttered in one of the tales.

To one who has listened to suffragettes, the speech of Miss Bennett, on behalf of the ladies of T.S., came as a welcome surprise, and recalled ancient days when man was considered to be lord of creation. Miss Bennett starting by expressing her feelings of awe at being in the presence of so much brain power. She could but feel humble at the thought of all the technical knowledge concentrated in that room. From this proper beginning Miss Bennett developed a charming eulogy of Mr. Slingo's work with the ladies of T.S., finally pointing out that as a result of Mr. Slingo's classes, test work was now done by ladies which a few years ago was considered only possible by men. Perhaps the sting was there after all!

After Mr. Brooker, who was received with considerable applause, had added his quota to the praise of his old chief, Mr. Slingo replied.

It was an earnest speech, showing at every point his love for the old school and the old days. Mr. Slingo said clearly and with evident sincerity that the school was his life work, and that he would have preferred to have carried on the school to being Engineer-in-Chief. He considered the school had potentialities which would have made it invaluable to the Department, and he thought the closing of it was a great mistake. As regards the remarks made by Mr. Jayne, he said it was for the staff at T.S. to show that it was capable of greater things. There was a period in the past when T.S. was looked upon with scant favour by the powers that be, but by perseverance they had shown that there were just as good, and perhaps better men in T.S. as elsewhere in the kingdom. The result was shown by the number of old T.S. men in the higher grades of the Engineering Department to-day. He was a believer in the marshal's baton in the knapsack of all, but it rested with the telegraph clerks themselves to show that they were capable of rising to higher things. He thanked all for the many things said about him, and stated that he considered that no greater compliment could be paid to any man than the gathering that evening, which showed that his work had been appreciated.

Many other points were dealt with in the speech, which was loudly applauded at the close.

The gathering was unique from the underlying enthusiasm of the audience, and although the few present who were not old students may have felt at times that they were in some way inferior or less blessed on that account, we are sure they looked with kindly eyes on the "T.S.'ites" preening themselves and strutting, as after all it was only for one evening.

When reflecting afterwards on the many aspects of Mr. Slingo that had been touched upon by the various speakers, one incident

Digitized by Google

served to stand out more than the others owing to its incongruity, but at the same time its humanness. Who could imagine the present Engineer-in-Chief organising and marching at the head of a mighty singing host from the City to the West End on the occasion of the rejoicings at the recovery of the Prince of Wales (late King Edward VII) from a dangerous illness? Mr. McEwan assured us he saw it with his own eyes, and from the description of the happenings attending the march it appears that to the list of things Mr. Slingo has invented must be added what is known as Mafficking. The march was such a success that it was duly recorded in the papers, the credit, however, being given to medical students, instead of to the actual leaders—the youths of TS. It is good to recall in these strenuous times that an Engineer-in-Chief has had his moments of abandon!

S. C. BARTHOLOMEW.

BATH TELEPHONE SOCIETY.

THE seventh meeting of the Session was held on April 17th, 1912, Mr. W. C. Owen (President) in the Chair. Papers were read in the Traffic Competition by Misses Owen, Hall, King-Smith, Garlick (2), and Mr. E. E. Lea, the last named expressing the hope that the Department would adopt the South African system of telephoning telegrams, or a modification applying to telegrams between points in the same telephone area.

Prizes were awarded in the above competition: Mr. E. E. Lea, first, and Miss D. A. Owen, second; and in the recent General Competition: Mr. F. C. Hall, first, and Mr. W. F. Bowden, second.

With this meeting the second session was brought to a successful close, and the members are to be congratulated on the enterprise and *esprit de corps* which secured in a large and scattered Centre an average attendance of 89·86 per cent. of the membership, this being a slight decrease on last year (91·98 per cent.)

CORRESPONDENCE.

SPECIAL PRIZES OFFERED BY THE MONTEFIORE ELECTRO-TECHNICAL INSTITUTE.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

GENTLEMEN,—We have the honour of acquainting you with the conditions of the 1914 Competition of the George Montefiore Foundation, instituted by our late Honorary President, the founder of the Electro-Technical Institute which bears his name.

Digitized by Google

We shall be obliged if you will give this information the widest possible publicity.

Accept the assurances, etc.,

For the Administrative Council of the Association of Electrical Engineers, emanating from the Montefiore Electro-Technical Institute,

O. DE BAST, *President.*
G. L'HOEST, *General Secretary.*

Social Head-quarters,
Rue Saint Gilles, 31, Liége.

GEORGE MONTEFIORE FOUNDATION TRIENNIAL PRIZE. CONDITIONS OF THE 1914 COMPETITION.

(1) A prize, of which the amount will be comprised of the accumulated interest on a capital of 150,000 francs (£6000 approx.) invested in Belgian stock at 3 per cent. per annum, will be awarded every three years, and for the first time in 1911, as the result of an international competition, for the best original work presented on scientific advancement and on progress in the technical applications of electricity in all its branches, excluding works of vulgarisation or simple compilations.

(2) The prix will bear the title, "The George Montefiore Levi Foundation."

(3) Only those works will be admitted to the competition which are presented during the three years preceding the meeting of the jury.

They must be drawn up in French or in English and may be printed or in manuscript. In all cases manuscripts must be legibly type-written.

(4) The jury will be composed of ten electrical engineers, five Belgian and five foreign, under the presidency of the Professor-Director of the Montefiore Electro-Technical Institute, who will, of course, be one of the Belgian delegates.

Save for exceptions authorised by the founder, the latter must be holders of the diploma of the Montefiore Electro-Technical Institute.

(5) By a majority of four fifths in each of the two sections, foreign and national (which must, for this purpose, vote separately), the prize may be exceptionally divided.

By the same majority the jury may award a third of the funds at its disposal as a maximum for a capital invention to a person not having taken part in the competition or to a work which, without completely complying with the programme, shows a new idea that may have important effects in the electrical kingdom.

(6) In the event of the prize not being awarded, or if the jury shall have awarded only part of it, the remainder of the available funds shall be added to the prize of the next triennial period.

Digitized by Google

(7) By the application of the foregoing provisions, the amount of the prize to be given in 1914 is fixed at five thousand francs (£200 approx.).

(8) Type-written works may be signed or anonymous. Any work not bearing the legible signature and full address of the author will be regarded as anonymous.

Anonymous works should bear a device which should be repeated on a sealed envelope attached to the work sent. Inside the envelope the surname, the christian name, the signature and the residence of the author should be legibly written.

(9) Twelve copies should be furnished of all works, whether printed or typewritten. They should be addressed, post prepaid, to M. le Secrétaire-archiviste, la Fondation George Montefiore, rue St. Gilles, 31, Liége, Belgium.

They should bear at the head of the text in a clear manner the following title: "Work submitted for the competition for the George Montefiore Foundation, 1911 session."

The Secretary-Archivist will acknowledge receipt of communications from authors or senders who make themselves known.

(10) The works judged by the jury will be published in the 'Bulletin of the Association of Electrical Engineers' emanating from the Montefiore Electro-Technical Institute. Such publication shall give to authors no right to claim any expenses in connection with or any remuneration for their works. Nevertheless they will be sent as an act of grace twenty-five copies.

For this publication English texts will be translated into French by the Association.

(11) The latest date of reception for works to be submitted to the jury for the 1914 Session is March 31st, 1914.

For the Administrative Council of the Association of Electrical Engineers emanating from the Montefiore Electro-Technical Institute.

OMER DE BAST, *President.*
GUSTAVE L'HOEST, *General Secretary.*

BOOKS RECEIVED.

'The Public Ownership of Telephones on the Continent of Europe,' by Dr. A. N. Holcombe. (London: Constable, 1911, xi + 482 pp. Price 8*s*. 6*d*. net.)

This book, dealing with a subject of special interest to the readers of the POST OFFICE ELECTRICAL ENGINEERS' JOURNAL, forms volume VI of the "Harvard Economic Studies," and was published under the direction of the Department of Economics.

Digitized by Google

The object of the writer is well set forth in the preface, as follows:

"This book has not been written to prove that any one mode of conducting the telephone business is the best for all countries and under all circumstances. I have simply tried to set forth without prejudice the results of European experience in the conduct of the business. My object is to make available the evidence upon which the reader may form his own opinion of the value of the various policies that have been adopted. When it has seemed instructive to do so, I have not hesitated to make comparisons between American and European conditions; but the purpose has always been, not to propose alterations in the contemporary American policy towards the telephone industry, but to make more clear the nature of the European situation. The aim is not to show that a particular mode of conducting the telephone business—say free competition or public ownership—is in the abstract the best, but to show how in practice various forms of industrial organisation actually have worked."

And the method of its achievement is set forth thus:

"The official reports of telephone companies and administrations have been studied, as well as the parliamentary debates upon telephone affairs, the technical periodicals dealing with the telephone industry, and the pamphlets and books on the subject. Conversations have been had with telephone officials, both in public and in private systems, in high and in low position, in favour of and opposed to each of the several modes of conducting the telephone business; with technical experts and inventors not employed directly in any system; with labour leaders whose chief interest in the telephone was as a source of employment to wage-earners; with business men and other telephone-users, and with economists and officials whose interest lay largely in the form of industrial organisation of the telephone business. To write the book would have been impossible without the cordial support of practical telephone men. I am under deep obligations to many more of these than can be named here. Telephone officials, both in the public and in private service, have placed their stores of information at my disposal, and have given generously of their ripe experience and trained judgment. My obligations cannot be expressed to them all individually. Yet I cannot neglect the opportunity to record my appreciation of them as a class. If this book does no more than to aid in the establishment of more general confidence in the efficiency and loyalty of the trained administrator and technical expert, whether in the employ of a private or of a public monopoly, the labour of writing will have been repaid."

The last few sentences are pleasant reading to telephone officials.

After an introductory chapter on the origin of European state telegraphs, Dr. Holcombe devotes Part I with its ten chapters and some two hundred pages to an exhaustive description of the telephone situation in Germany, including therein much that is of interest on the subject of the operation of the German economic organisations.

On the vexed question of comparative technical progress under public or private ownership Dr. Holcombe's conclusions must carry considerable weight. With regard to Germany he says:

"Opponents of the policy of public ownership of business undertakings sometimes assert that nevertheless the tendency of such undertakings is to hinder industrial progress because they offer no adequate stimulus to invention. Thus a modern French opponent, Paul Leroy-Beaulieu, after alluding to the work of the

Digitized by Google

great inventors and men of science of the nineteenth century, observes:* 'The State on the contrary invents nothing.' This is, of course, true. It is equally true that private business corporations invent nothing. Inventions are the inexplicable products of human ingenuity. If there were no opportunity for the remunerative exploitation of these products of human ingenuity, and consequently no incentive to appeal to the self-interest of inventors, it is probable that inventions would nevertheless continue to be made. Perhaps not so many men of an inventive turn of mind would sacrifice their health in the pursuit of fortune, but few would deny themselves the pleasure of exercising their inventive faculties. The maintenance of the supply of inventions would be insured not only by the *amour propre* of the individual, but also by the very nature of the inventive faculty itself.

"The important matter from the point of view of the public is to make suitable arrangements for the testing and proper application of the really valuable inventions. Under the *régime* of free competition this is provided for automatically by the play of private enterprise. If an inventor has hit upon a valuable idea he should have no difficulty in obtaining financial backing and thus in being enabled to put his invention before the public. The public will then determine by means of the automatic operation of the ordinary forces of demand and supply the reward which the promoters of the invention are to receive for the work they have performed and the risks they have undertaken. The desire for this reward insures the testing and proper application of the really valuable inventions.

"Under a *régime* of monopoly it is not practical to employ this rough and ready method of threshing the wheat from the chaff. The policy of granting special concessions, authorising private enterprise to exploit an invention for a limited period of time is open to the objection that it violates the principle of monopoly. For example, it is absurd to organise innumerable stock companies and to establish innumerable rival telegraph systems in order to ascertain the comparative merits of the devices for increasing the speed of telegraphy, which are associated with the names of Wheatstone, Murray, Pollak and Virag, Siemens and Halske, Meyer, Baudot, Mercadier, Rowland and Delany, to say nothing of the divers other similar contrivances, already born or about to be born from the fertile brains of our inventive geniuses. There is no alternative but to substitute for the principle of competition that of organisation."

The completeness of the German organisation is indicated by the following paragraph:

"In Germany a special office in the telegraph service was created in 1876, and its incumbent was charged with the duty of following contemporary scientific affairs and encouraging technical research in the field of telegraphy. In 1888 this office was expanded into a bureau. In 1899 the bureau was expanded into an experimental station.† At the present day also a *Stadiumgesellschaft* is maintained as a co-operative undertaking by the government and the two great electrical concerns, the *Allgemeine Elektrizitäts-Gesellschaft* and the Siemens and Halske-Schuckert Works. Moreover the close connection between the German governments and higher education enables them to secure the co-operation of specialists engaged in advanced research work in the fields of physical and chemical investigation with the technical corps of their business undertakings. The entire scientific force of the nation is so organised as to render the most efficient service in the

* 'L'état moderne et ses fonctions,' 3rd edit., 1900, p. 49.

† Jung, II, p. 92. Since 1886 special appropriations have been sanctioned also by the Bavarian Landtag for the purpose of encouraging scientific research with a view to the improvement of the state railroad, postal, telegraph and telephone undertakings. *Cf.* 'Statistischer Bericht Bayerischer Verkehrsanstalten,' 1890, pp. 145–64.

Digitized by Google

solution of practicable problems. Thus the administrative officials are not only in a position to follow easily the technical developments in their department, but also to grant subsidies when expedient, in order to encourage the prosecution of the promising investigations."

There is much of interest as to the organised manner in which the needs of telephone users are studied by the chambers of commerce, who are in close touch with the telephone department. Rate policy receives exhaustive treatment, and an excellent chapter is devoted to the consideration of the labour situation in the Germany telephone service.

Part II deals with Switzerland and Part III devotes five chapters to France, the remaining countries of Europe being dealt with more summarily in Part IV, which also includes valuable chapters: (*a*) Comparative telephone rates; (*b*) comparative telephone development; and (*c*) Dr. Holcombe's final summary on the economy of public ownership.

The last-named chapter is of such interest and importance that I feel strongly the temptation to quote it *in extenso*. I shall, however, restrict myself to some significant paragraphs sufficient to wet the appetite of my readers and ensure that they will obtain and carefully study Dr. Holcombe's valuable treatise.

From the concluding chapter I quote as follows:

"According to the theory of the harmony of economic interests the best security for the production of those commodities which the community wants, and the best protection against the production of those which it does not want, is to leave business men free to engage in whatever branch of production they choose. For, it is argued, the test of a want that ought to be satisfied is the willingness of the consumer to defray the cost of satisfying it. Hence the desire of business men for a profit is a sufficient incentive to induce them to direct the production of those commodities that are wanted and no others. By permitting business men to compete freely with one another the amount of these profits may be reduced to a minimum, and the community will accordingly be supplied with the goods it desires at the lowest possible prices. The prosperity of a society that is organised in accordance with this theory depends, therefore, on the correctness of the prediction of the society's wants by business men, on their ability promptly and accurately to direct the productive forces of the community out of those channels where they are not wanted and into those where they are wanted, and on free competition between them.

"In the telephone business competition is a failure. Considered as an automatic arrangement for maintaining an accurate adjustment of the supply of telephone facilities to the demand, it easily gets out of order. So long as it remains in order its effect is to diminish the utility of the service to render which telephone facilities are created. For a while it is capable of bringing about low rates and stimulating a rapid development. Sooner or later, however, the self-interest of the competitors or the disillusionment of the public authorities will cause the termination of competition and the substitution of a *régime* of monopoly. This has been the result everywhere in Europe where competition has once existed, except in Stockholm, and in Stockholm the bankruptcy of the private company or the purchase of its business by the government is only a matter of time. Com-

Digitized by Google

petition as a permanent status in the telephone business is neither desirable nor possible.

"The alternative to competition is monopoly. But under a *regime* of monopoly the set of conditions from which is deduced the theory of the harmony of economic interests does not exist. The same motives of human conduct which, under a *régime* of free competition, are relied upon to secure to the community at reasonable prices the supply of those commodities and services which are wanted, no longer produce that result. There is, on the contrary, a direct antagonism of interest between the producer and the consumer. The latter, which is the community itself in the case of a business of general public importance, must make a special effort of some kind in order to provide a substitute for the automatic action of free competition. This special effort may take the form either of public regulation or of public ownership of the business in question.

"The problem is twofold. First, there must be a substitute for the action of free competition as a protector against inefficient management and the uneconomical employment of the productive forces of the community. Secondly, there must be some means of assuring to the community its share in the results of efficient management and economy in operation.

"We are now in a position to affirm with tolerable certainty in the cases of at least three countries on the Continent of Europe that state agency either has or has not bungled miserably. The tests of the efficiency of the management of a business undertaking are these: Is the demand estimated correctly? and is the supply adequate in quantity, satisfactory in quality, and delivered at a reasonable price? The evidence on which the response to the first of these test questions must be founded constitutes itself the response to the second. The standard of judgment as to the adequacy and efficiency of the telephone service supplied in Germany, Switzerland, and France and as to the reasonableness of the rates should not be an arbitrary one, however, but should be based on the requirements of telephone users in the three countries concerned. Each consumer is entitled to judge for himself what manner of service is a satisfactory equivalent for a given expenditure. The task of the disinterested critic should be confined to supplementing the judgments of the users, in so far as public opinion in a community may be ill informed in regard to the character of service which is supplied in other communities under similar conditions.

"Applying this standard of judgment, it appears that the German and Swiss telephone authorities have maintained a telephone service that has been both adequate in quantity and satisfactory in quality. The Germans originally established a schedule of rates that was reasonable under the existing conditions, and although for a period, in consequence of the subsequent changes in the character of the demand, that original schedule fell out of accord with altered conditions, it was ultimately subjected to a succession of reforms, designed to readjust the rates to the new conditions and on a basis calculated to enable the community to derive the maximum utility from its telephone system. The Swiss secured a wider and more prompt utilisation of the telephone than occurred anywhere else on earth, led the way in the substitution of measured service for unlimited service, and have ever operated a technically sound system at rock bottom rates. The French telephone authorities, on the other hand, have not succeeded in maintaining either an adequate quantity or a satisfactory quality of telephone service, nor in establishing their rates on a reasonable basis. In short, we find that on the basis of the experience of the continental European governments in the conduct of the telephone business, no general statement can be made concerning the efficiency of state agency in the conduct of business undertakings. The nearest approach to a general statement that can be made is that in some countries public enterprise has

Digitized by Google

Digitized by Google

O'MEARA CUP.

THE NORTHERN DISTRICT TEAM, WINNERS OF THE 1912 COMPETITION.

T. CAIRNS. W. TAYLOR. S. A. POWELL. R. D. S. NORMAN.
W. M. BATCHELOR. J. McL. ROBB (*President*). H. KITCHEN (*Captain*).
F. HANN. "O'MEARA" CUP, "GRACEY" CUP. J. S. CROSS.

Digitized by Google

bungled miserably in the telephone business, and that in others public enterprise has not bungled at all."

The reasons for, and the causes of these succcsses and failures are stated with great ability and discrimination, and contain valuable lessons which the reader will gladly learn.

The reviewer has found the perusal of the book at once a pleasure and a privilege. At the present critical period in the history of the British telephones the value of such a work is at a maximum, and the Department would be well advised to purchase a number of copies for the information of controlling officers. D. H. K.

O'MEARA CUP.

1912 COMPETITION.

THE result of the above competition was as follows:

Northern District Team	581 points.
Engineer-in-Chief's ,,	579 ,,
South-west District ,,	569 ,,
Met. South ,, ,,	562 ,,
South-east ,, ,,	561 ,,
Scotland, East ,, ,,	541 ,,
North-east ,, ,,	527 ,,
Eastern ,, ,,	476 ,,
Ireland ,, ,,	did not shoot.

Total number of points possible, 600.

The Northern District team has only been in existence since March, 1910, but by dint of steady practice several members of the team are now good marksmen.

The "Gracey" Cup, which was presented by the Newcastle Postmaster-Surveyor (J. Gracey, Esq.) for competition between the different branches of the Newcastle P.O. has been won by them two years in succession. The team has only sustained one defeat in sixteen matches.

A rather strange coincidence in connection with the O'Meara Cup competition is that last year's winners, the Engineer-in-Chief's team, defeated the Northern District by 2 points, and this year the tables have been exactly reversed, the Northern District having defeated Engineer-in-Chief's Office by 2 points, with a score of 581 points out of a possible 600.

The following were the winners' individual scores in this year's competition:

Digitized by Google

F. Hann	99 points.
W. M. Batchelor . . .	97 ,,
H. Kitchen	97 ,,
R. D. S. Norman . . .	97 ,,
S. A. Powell	96. ,,
T. Cairns	95 ,,
W. Taylor	95 ,,
J. S. Cross	93 ,,

ROWLAND HILL FUND.

An interesting function took place at Bishopsgate Institute on Wednesday, May 15th. The Telephone Staff of the Dalston District arranged a concert and lantern lecture to mark the fusion of the late National Telephone Company's Benevolent Society with the Rowland Hill Benevolent Fund, and the successful issue to which Mr. F. Morley Ward and his active Committee carried their efforts at a time of the year when people generally prefer the tennis court to the lecture hall speaks well for the attractiveness of the programme.

Mr. A. M. J. Ogilvie, C.B., the Secretary of the Post Office who has charge of the Telephone Service, was supported in the chair by Mr. C. B. Clay, the President of the Benevolent Fund which has now ceased to exist as a separate organisation. Other gentlemen present included Messrs. Deputy Lulham Pound, Lea Smith, and Ross Collins, Trustees of the Fund, and Mr. Dudley Stuart, Chairman of the Committee of the late Company's fund. In his opening remarks the Chairman described the events which led up to the amalgamation of the two funds, and during the evening Mr. Clay, in a few well-chosen words, traced the financial history of the Company's fund.

It would be difficult to apportion the praise due to the artists who rendered the musical part of the programme. They vied with each other in provoking appreciative rounds of applause. Miss Bessie Harlow and Messrs. Fred Hudson, G. W. Livermore and G. Pollard with their songs, Miss Maud Mason as a reciter, and "Musicus" with his performance on all sorts of weird musical instruments.

The main portion of the programme, however, was occupied by Mr. Ernest E. Gawthorn with his lantern lecture entitled "His Majesty's Mails."

After briefly sketching the history of the Post Office from the days of the original post-boys to such up-to-date methods as aërial

Digitized by Google

posts, the lecturer took his audience for a trip with a letter from posting in a southern county to deliver in a northern one, *viâ* the G.P.O., also to Canada.

The method of collecting and delivering mails from trains travelling at high speed and the growth of the transatlantic service from the frigate to the "Olympic" was particularly interesting, and with his many anecdotes and internal knowledge of the postal service Mr. Gawthorn was able to afford his audience an instructive as well as an intensely amusing evening's entertainment.

POST OFFICE ENGINEERING DEPARTMENT.

STAFF CHANGES.

PROMOTIONS.

Office.	Name.	Appointment.	Previous Service.
Eng'g Dept.	Kennedy, D. H.	Asst. Suptg. Engr. (L.)	'85; Jr. Clk, Eng'g Dept., '95; Sub. Engr., '96; Engr., 2nd Cl., '98; 1st Cl., '01; Staff Engr., 2nd Cl., '07.
,,	Batchelor, W. M.	,, (P.)	'85; Jr. Clk., Eng'g Dept., '92; Engr., 2nd Cl. '00; 1st Cl, '06; Staff Engr., 2nd Cl., '09.
,,	Lewis, T.	,, (P.)	S. C. & T., Newport (Mon.), '84; Jr. Clk., Eng'g Dept., '92; Engr., 2nd Cl., '98; 1st Cl., '02; Exec. Engr., '11.
,,	Atkinson, J. W.	Asst. Staff Engr. (L.)	'93; Jr. Clk., Eng'g Dept., '99; 3rd Cl. Clk., '00; Engr., 2nd Cl., '03; 1st Cl., '09.
,,	Brown, H. P.	,,	'97; Jr. Clk., Eng'g Dept., '99; 3rd Cl. Clk., '00; Engr., 2nd Cl., '03; 1st Cl., '09.
,,	Lee, A. G.	,,	'95; 2nd Div. Clk., '99; 3rd Cl. Clk., Eng'g Dept., '01; Engr., 2nd Cl., '03; 1st Cl., '09.
,,	Brown, H.	,,	'90; Jr. Clk., Eng'g Dept., '97; Sub. Engr., '99; Engr., 2nd Cl., '03; 1st Cl., '10.
,,	Walters, E. H.	,,	'04; 1st Cl. Engr., '10.
,,	Brown, J.	Executive Engr. (L.)	'88; Jr. Clk. Eng'g Dept., '98; Sub. Engr., '99; Engr. 2nd Cl., '03.
,,	Pink, E. A.	,, (P.)	'87; Relay Clk., '98; Engr., 2nd Cl. '03.
,,	Hines, J. G.	,, (L.)	'93; Jr. Clk., Eng'g Dept., '00; Engr., 2nd Cl., '03.
,,	Fulcher, H. W.	,, (L.)	'05.
,,	Carter, W. G.	,, (L.)	'05; Asst. Engr., '11.
,,	Rolfe, W. J.	Asst. Engr. (P.)	'83; Sub. Engr., '98; Engr., '01.
,,	Billingham, G. W.	,, (P.)	'84; Jr. Clk., Eng'g Dept., '96; Sub. Engr., '98; Engr., '01.
,,	Fitzpatrick, G. A.	3rd Engr., "Monarch"	'12.

Digitized by Google

STAFF CHANGES.

TRANSFERS.

Name.	Rank.	District.		Date on and from which to take effect.
		Former.	Present.	
Price, J. P.	Asst. Supt. Engr.	Met. S.	S.E.	1 : 11 : 11
Sullivan, J. W.	,,	M.	N.W.	1 : 11 : 11
Atkinson, J. W.	Executive Engr.	S.W.	E. in C.O.	1 : 12 : 11
Brown, H. P.	,,	Met. C.	,,	1 : 12 : 11
Cunningham, R.	,,	N.W.	Sc. W.	2 : 5 : 12
Upton, S.	,,	Ire.	,,	1 : 1 : 12
Upton, S.	,,	Sc.W.	N.W.	2 : 5 : 12
Billingham, G. W.	Asst. Engr.	E. in C.O.	Ire.	26 : 11 : 11
Billingham, G. W.	,,	Ire.	N. Wa.	4 : 12 : 11
McDonald, C. G. A.	,,	E. in C.O.	,,	1 : 4 : 12
Pink, E. A.	,,	Met. S.	S.W.	19 : 11 : 11
Rolfe, W. J.	,,	E. in C.O.	N.W.	27 : 3 : 12
Scott, A.	,,	N.	Sc. E.	7 : 1 : 12
Gardner, A. W.	2nd. Cl. Engr.	E. in C.O.	E.	1 : 2 : 12
Golding, W.	,,	Ire.	S. Wa.	2 : 2 : 12
Grace, H.	,,	Sc. E.	E. in Co.	10 : 2 : 12
Hammond, E. J.	,,	Ire.	N.W.	23 : 1 : 12
Lawson, R. J.	,,	Met. C.	Sc. E.	10 : 2 : 12
Marr, H. R.	Probationary Sub-Engr.	E. in Co.	E.L. and P.	1 : 1 : 12
Adams, J. W. T.	2nd. Class Clerk	N.W.	S.W.	18 : 2 : 12
Robinson, W. D.	3rd. Class Clerk	Factories Dept.	E. in Co.	1 : 1 : 12
Bewley, H. L.	,,	N. Wa.	N.W.	27 : 12 : 11
Brown, H.	,,	S.E.	Met. S.	28 : 12 : 11
Brown, W. G.	,,	Met. S.	E. L. and P.	23 : 2 : 12
Canavan, P. J.	,,	N.W.	Ire.	24 : 3 : 12
Dall, C. A.	,,	S. La.	Sc. E.	17 : 3 : 12
Donaldson, J. G. K.	,,	Ire.	N. Wa.	27 : 2 : 12
Dore, A. H. M.	,,	M.	S.W.	24 : 3 : 12
Eachus, R. S.	,,	Sc. W.	N. Wa.	22 : 4 : 12
Gwilliam, A.	,,	E.	S.W.	10 : 3 : 12
Hewish, B. F.	,,	N.W.	N.Wa.	27 : 12 : 11
Wilson, W. A.	,,	S. Wa.	,,	25 : 3 : 12

COMMUNICATIONS.

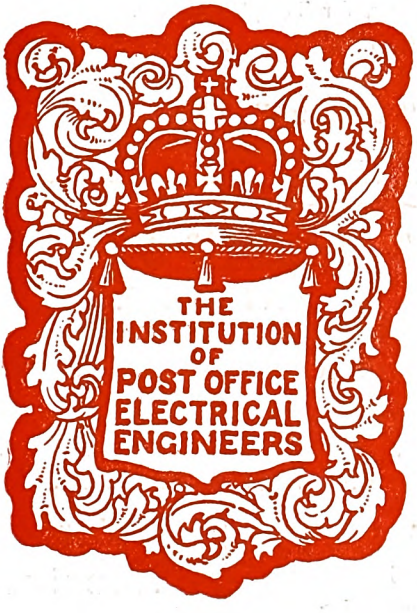
All Remittances and Agents' Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

Editorial Communications and Correspondence should be addressed to Mr. D. H. KENNEDY, Norbiggin, 26, Oakley Avenue, Ealing, W. (Telephone, 1000 Ealing.)

Digitized by Google

HARVARD UNIVERSITY

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL



VOL. 5 PART 3

OCT: 1912

Google

ESTABLISHED 1879.

THE

LONDON ELECTRIC WIRE COMPANY AND SMITHS, LTD.

Telegrams: "Electric, London." Telephone: No. 3105 London Wall.

Playhouse Yard, Golden Lane, London, E.C.

MANUFACTURERS OF

Every Description of Cables & Wires for Electrical Purposes.

Cotton-Covered & Braided Wires, Strips & Cables.
Silk-Covered Wires for Electrical Instruments.
Enamel Insulated Wires.
Multiple Cables for Telephones, &c.
Flexible Cords of all descriptions for Incandescent Lamps, &c.
Dynamo Brushes.
"Platinoid," "Eureka," AND OTHER **High Resistance Wires.**

Antwerp Telephone & Electrical Works,
ANTWERP.

Manufacturers of

TELEPHONIC APPARATUS

OF EVERY DESCRIPTION.

Wall Sets
Table Sets
Switchboards
Standard and Multiple
Domestic Sets

Bells
Receivers
Transmitters
All Accessories

Sole Agents for the United Kingdom—

W. F. DENNIS & CO.,

49, QUEEN VICTORIA STREET,
LONDON.

Stores: MILLWALL DOCKS, E.

Telegrams: "FREDENNIS, LONDON." Telephone: BANK 343.

Digitized by Google

Digitized by Google

A Typical English Aerial Line.

Verulam Road, St. Albans. "H" Pole Line carrying the "Birmingham Road Line" and the "Acquired Trunk Line."

Digitized by Google

THE
Post Office Electrical Engineers' Journal

FIRE AT THE CENTRAL TELEGRAPH OFFICE, LONDON.

THE evening papers of Saturday, August 24th, 1912, conveyed to London the startling information that a serious outbreak of fire at the Central Telegraph Office had resulted in the complete telegraphic isolation of the metropolis from the outside world. This unprecedented event in the history of the British telegraph system occurred about 7 p.m. One of the officers on duty in the main test-room on the third floor of the G.P.O. West building observed smoke rising from the floor in front of the large test-box which serves the whole of the provincial gallery, and through which nearly 1000 important telegraph circuits pass. An immediate alarm was given, and the official firemen were very soon on the spot. Meanwhile, the raising of one of the flooring flaps had shown that the floor bearers and the contents of the wire runs were well alight, and that the fire had obtained a firm hold under a considerable portion of the test-room area. The local supplies of sand and other fire-extinguishing material were used up without much result, and when the London Fire Brigade arrived, a few minutes later, it was recognised that free use of the hose was the only course that would effectively cope with the situation. This speedily extinguished the fire, but not before it had spread so far as to involve the whole of the lines entering and leaving the test-box. So alarming had the condition of matters been, that it was considered advisable to order the operating staff to leave the building. As a further precautionary measure all sources of electrical and pneumatic power were shut off when the nature of the outbreak became apparent. As soon as the fire had been extinguished these were cautiously re-connected; the electric light was restored, the pneumatic and conveyor systems re-started,

Digitized by Google

Digitized by Google

and the telegraphic power leads serving other floors of the building were again joined up to the accumulators. After an interval of little more than half an hour's suspension communication was thus re-established on the circuits to all London district offices, which, with the Metropolitan inter-communication switch, are located on the fourth floor, to the whole of the foreign cities connected telegraphically with London through the "foreign gallery" on the second floor, and to a considerable number of offices, chiefly in the "home counties," which are also served by circuits terminated on the second floor. But the whole of the third floor provincial galleries, the great ganglion centre of the national telegraph system, remained dead.

The amount of actual destruction caused by the fire was comparatively small, but the blow had fallen in a vital part and its effect was out of all proportion to the material damage. It occurred at a time when only a small portion of the engineering staff was on duty. Arrangements for calling out the staff in an emergency had been carefully prepared and were at once acted on, with the result that controlling officers were soon on the spot, with an adequate amount of assistance. Even before the fire was extinguished steps were being taken to make such restorations of communication as could be effected at the main test and distribution frame in the basement of the building, and by utilising junction cables from this test frame to the second floor test-box. Connection between the special newspaper wires and the Fleet Street offices was re-established by direct cross-connections in the basement. The provincial wires to the Stock Exchange were made good in the same way, and the large and well equipped Stock Exchange Telegraph Office was utilised for ordinary public traffic to the utmost of its capacity, by similarly joining through to it selected wires from some of the main provincial post offices. The "news" service was speedily reopened by connecting the most important "Y Q" news wires to junction lines between the basement and the second floor test-box, from which point they were extended to selected apparatus sets equipped with high-speed Wheatstone instruments. In this way communication was re-established, before 10 p.m., to Manchester, Liverpool, Leeds, Birmingham, Preston, Bradford, Newcastle, Edinburgh, Glasgow, Bristol, Plymouth, Dublin, and Belfast. A further group of ten telephone junction lines to the second floor test-box was used to reconnect important provincial circuits to large offices which could act as main transmitting centres. These circuits were connected to Wheatstone apparatus sets borrowed from the service of "home county" offices which had other channels available. Further relief channels were also provided by bringing into use the superimposed telegraph call-wires which are ordinarily used for the

Digitized by Google

transmission of trunk service particulars at the London Trunk Telephone Exchange.

Meanwhile the question of the most effective method of restoring life and energy to the stricken provincial galleries was the subject of a council of war.

The incoming line leads reached the third floor test-box by means of a series of multiple, lead-sheathed, paper-core cables, rising in a chute against the outer wall and terminating in the test-room in cable connection boxes fitted to the wall. Thence the lines passed under the floor to a set of switchboards used for "morning testing," then again under the floor to the test-box itself. After passing through the test tablets they were carried in lead-covered silk and cotton-core cables to "divisional" test-boxes fitted in the various main divisions of the office. The upper ends of all the incoming cables were destroyed near the point where they entered the cable connection boxes, the lead sheathing being melted and the paper insulation burned away. The whole of the under-floor wiring was burned and the outgoing ends of the numerous cables running to the divisional test-boxes were similarly destroyed. The lower portion of the main test-box, in which the connection tag and "jumper" strips were fitted, had also suffered considerable damage, and the whole of the damaged cables and wiring were drenched with water. The accompanying photograph, which shows one end of the test-room, will give some idea of the position. The end panels of the main test-box are seen on the right, while directly in front are the secondary cell power-distributing and fuse tablets. The morning test switchboards occupied a position near the centre of the burned flooring and the cable connection boxes for the incoming line cables were fixed to the wall on the left.

It was perfectly evident that it was impossible to restore the test-box to a workable condition in anything like reasonable time, and it was therefore decided to cut it out entirely by joining the incoming cables directly through to the divisional test-box cables. The fact that the "cross-connecting field" of the test-box had been destroyed suggested the installation of new distributing frames, since the wires in any given incoming cable were liable to require connection to conductors in many different divisional cables. It was clear, however, that the all important desideradum was to have the work of through connection completed, in some sort of temporary fashion, before the resumption of heavy traffic on Monday morning. The position at which good ends could be picked up on the divisional cables, and considerations of the limited space available, led to the conclusion that the most effective method of rapid restoration would be to connect the cable conductors on the two sides straight through to each other without the intervention of any soldering tags or

Digitized by Google

jumper wires. The flooring was removed from over the ends of the converging cable runs on the instrument-room side of the test-box, and this spot became the centre of operations. Men were detailed to strip the lead sheathing from the ends of the divisional cables, and, as soon as sound cable was reached, the silk- and cotton-covered conductors were treated with melted beeswax, and the work of testing-out and labelling the circuits in each of them was started.

The identity of the wires in all the cables had of course been lost and had to be re-established by detector tests from the divisional boxes. The cables on the incoming side were cut on the floor below, beyond the point to which water had penetrated, and extension lengths of lead-sheathed silk and cotton cable were jointed to them there. These extension cables were carried up to the third floor, across the burned-out test-room, and underneath the test-box to the instrument-room side, where their ends were stripped, beeswaxed, and identified and labelled by testing-out from the basement test-frame.

Records were available showing the complete groups of circuits served by each cable, but that giving particulars of the divisional cables narrowly escaped destruction. The book was kept in a locker in the test-room and was rescued in a badly scorched condition. Fortunately its contents remained quite legible.

A supporting framework was extemporised by fixing stout maple rails between the test-box and the nearest instrument-table, eight or nine feet from it. To these rails the upturned ends of the cables were lashed and, as soon as the identification and labelling of the circuits had progressed far enough, the work of "marrying-up" the proper conductors on the "line" and "instrument" sides was begun. Solder was not used; the wire joints were simply twisted tightly together and protected by paper sleeves bound in position over them. In many cases the cable conductors on the two sides could be connected through by a single joint; when they were too short for this purpose a length of single "flame-proof" wire was cut in. Officers of the Stores Department had been early on the scene and there was a good supply of all kinds of material.

While the line work was proceeding the restoration of the battery power supply had also been taken in hand. Two groups, positive and negative, of eight main conductors, insulated with vulcanised rubber, and carrying voltages ranging from 20 to 150 volts, are led from the secondary cell room in the basement to each of the four distributing tablets shown in the photograph. There the supply current passes through test links and fuses and is distributed in wrought iron troughing by four independent sets of gallery mains, also insulated with V.I.R., and each teed to a large number of subsidiary distributing boxes on the instrument tables.

Digitized by Google

The fire had passed under the main distributing case and the ends of the gallery mains were all destroyed, but it was at first thought that the supply leads, which were run in thick grooved wooden casing from the battery room, had escaped damage. The first tests made showed their insulation to be very low, but this was put down to leakage on the surface of the slate tablets, which had become coated with a deposit of oily soot from the fumes of the burning rubber. It was a great disappointment to find that after being disconnected from the tablet they still tested "bad," and that they would have to be taken out of the distribution case. The grooved wood casings in which they were enclosed had been built "not for time, but for eternity," and their many superimposed thicknesses had to be slowly and tediously chiselled away, a few inches at a time, before the leads were clear. The casings had been saturated with water but the leads were practically undamaged by the fire and it was found that drying out with incandescent lamps for a few hours restored the insulation of a sufficient number of them to provide for the connection of an adequate number of working voltages to the distributing tablets.

All the tablets were taken out, and the slate and metal work was carefully cleaned. The distribution cabinet was of an old design, in which the tablets were fitted on a slope of 30° from the horizontal. This made access to the back of them very difficult; the top framework of the case was therefore cut off and fixed vertically by improvised supports before the tablets were refitted. The gallery mains were cut at points beyond the location of the damage, and a bight of fresh V.I.R. cable of adequate length was jointed into each of them. The burned lengths of cable were used to pull the new sections through to the distribution case, and the identity of each conductor was thus automatically preserved.

The work of restoring the connection of lines and batteries proceeded without intermission throughout the Sunday and the following night. It had been hoped that all communications would be made good by Monday morning, but it was unfortunately not possible to do so, and when the operating staff came on duty in full force at 8 a.m. a large portion of them had perforce to remain idle. This was mainly due to the unexpected difficulties in connection with the restoration of the battery power, and to those engaged on the work it also seemed to be due to the unprecedented speed at which the hands of the central telegraph office clocks kept racing around their dials! Delay to the traffic was, however, kept down in a remarkably successful way, and by about the middle of the day the bulk of the circuits were again in full operation. The remainder were rapidly made good, and the crisis was over.

The conditions of high pressure and very restricted space in

Digitized by Google

which the replacement had been carried out did not conduce to the production of exhibition work. The mat of cross connections between the incoming and outgoing line cables was not exactly a thing of beauty, and the operation of straightening out was proceeded with immediately. The test-box was stripped, its ebonite tablets were dismantled, all the brass test-holes and links were cleaned and replaced, and circuit positions were allocated and labelled. The damaged connection strips and jumper field in the lower portion of the box were discarded, and fresh sets of lead-covered cables were connected direct to the test-holes and run overhead to a point above the temporary cross-connecting mat; line cables to one side and instrument cables to the other.

Suitable supports were erected, and two rows of insulated jumper rings and guide pins were inserted on each side, one over the other, and about 2 ft. apart. Bit by bit the direct, cable to cable, connections were picked out, severed, and made good through the test-box, the conductors of each cable being drawn clear and threaded through a particular jumper ring. In this way the cross connections on both the line and instrument sides were restricted to the space between the rings and guide pins, an appearance of symmetry and safety was restored, and the wires were again put at the disposal of the test-box staff. The temporary erection was safely enclosed, and looks quite capable of serving until a complete new test-box and cabling system are installed.

The origin of the fire is not known. One's first impulse was to suspect that our friend the ubiquitous rat had managed to find his way to the main incoming power leads at some point, and by gnawing through the insulation had set up a short-circuit. But inspection showed that nothing of the kind could possibly have occurred. There remains a possibility that something similar may have occurred on the gallery side of the distributing tablets, on which 5-ampère fuses are fitted.

In exceptional circumstances a destructive arc may be set up and maintained without blowing a 5-ampère fuse, but there was good reason to locate the origin of the fire at a point about the centre of the test-room occupied by line leads only, and near which the gallery mains did not pass. If the fire really had an electrical origin, it therefore apparently originated among the line leads, and the magnitude of current possible in these leads is controlled by 1-ampère fuses at the instrument tables as well as by protective resistances which, even on dead short-circuit at any point beyond, would prevent the current on any line from exceeding half an ampère. Even with these small currents, conditions can be imagined in which a fire might be set up. If a wire lying against an earth connection should lose its insulation, to just the right degree and over a surface

Digitized by Google

of just the right extent, through the penetration of moisture, a speck of its covering may become slowly charred and reach a point of incandescence which might make it the cause of conflagration.

It is a tantalising feature of this particular fire that it occurred at a time when the plant involved was all in process of being superseded. In two months' time the third floor test-box and the morning test switchboards would have been thrown out of use and broken up, and the secondary cell distribution cabinet would, in a few months more, have shared the same fate. A new test-room has been constructed on brackets thrown out over the well of the building within a few yards of the old one, and in this room a complete new test-box was actually being installed in position at the time the fire broke out.

The cables will reach this new test-room by a route which is practically all outside the building and no wires other than those contained in large lead-sheathed cables will be used in its floor chases. A new design of secondary cell distributing board was also under construction for the same position, and on its completion it was intended to replace the whole of the existing V.I.R. power cables by cables of the lead-covered type. The forward state of these arrangements will much facilitate the final replacement of the damaged plant, and may be counted as a fortunate circumstance. Absolute safety from fire cannot of course be predicted, but it can be said with confidence that the arrangements proposed will render impossible the recurrence of a fire of the same character as that of August 24th.

The existing test-box, secondary cell plant, and wiring arrangements were installed about twelve years ago, and they then represented a great advance upon the conditions which had previously obtained from the standpoint of immunity from fire risks. Those who were familiar with the Central Telegraph Office twenty years ago and earlier will recollect that the building contained four large wooden wire chutes, having a section of about six feet by four, running right from the basement to the top floor and each of them almost filled with a mass of the most inflammable wiring, insulated with gutta-percha, indiarubber and ozokerit tape. Great bunches of similar wires ran in all directions under the floors of the galleries; they were indeed the only types of covered conductors then obtainable. A fire in such conditions would have involved the whole building in a very short space of time, but it never happened, and we have much reason to be thankful for that mercy.

But all the more so, perhaps, on that account, one may be pardoned for characterising as *bad luck* the fact that the existing much safer arrangement has met with misfortune on the eve of its replacement by something a good deal safer still.

The lessons to be drawn from the recent fire are general rather

Digitized by Google

than particular. Nothing has happened that has not all along been recognised as a possibility, and there is nothing in any of the attendant circumstances to throw doubt on the wisdom, or the reasonable adequacy, of the latest standard regulations laid down by the department for the equipment and wiring of its telegraph offices and telephone exchanges. The most clearly pointed moral is perhaps that the installation of up-to-date arrangements should not be too long delayed, and that conditions which are not the safest obtainable should not be allowed to remain merely because it is known that some general re-arrangement is contemplated which will probably provide an opportunity of introducing the most approved methods of construction more easily and cheaply at a later stage. I cannot refrain from mentioning the admirable way in which all ranks of the department's servants, from the district officers in charge down to the most junior assistant, planned and worked in the restoration of communication, and the eager energy with which they strove to make the most of the precious hours that fortunately intervened between the time of the fire and the recommencement of full normal traffic on Monday morning.

It was hard and long-continued work without flurry, no one lost his head, there was no muddle, and the plan of what was being attempted and accomplished was quite evident all through.

My account is merely that of a spectator who held himself throughout the critical period as a kind of emergency reserve that never needed to be called up, and who afterwards enjoyed the luxury of twelve hours' solid sleep without having done anything at all to deserve it.

T. F. PURVES

WHEATSTONE WORKING IN CANADA.*

By J. LOCKHART,
Llanfair.

THE Wheatstone working of which it is proposed to deal is that of the Pacific Cable Board's land line in Canada, and by way of introduction it will be of interest to give a short review of the All Red cable route to Australia, of which that line forms part.

After many years' agitation the demand for this cable resulted in the formal constitution of the Pacific Cable Board by Act of Parliament in 1901, which stipulated for eight members, three of whom represent His Majesty's Government, two the Government of

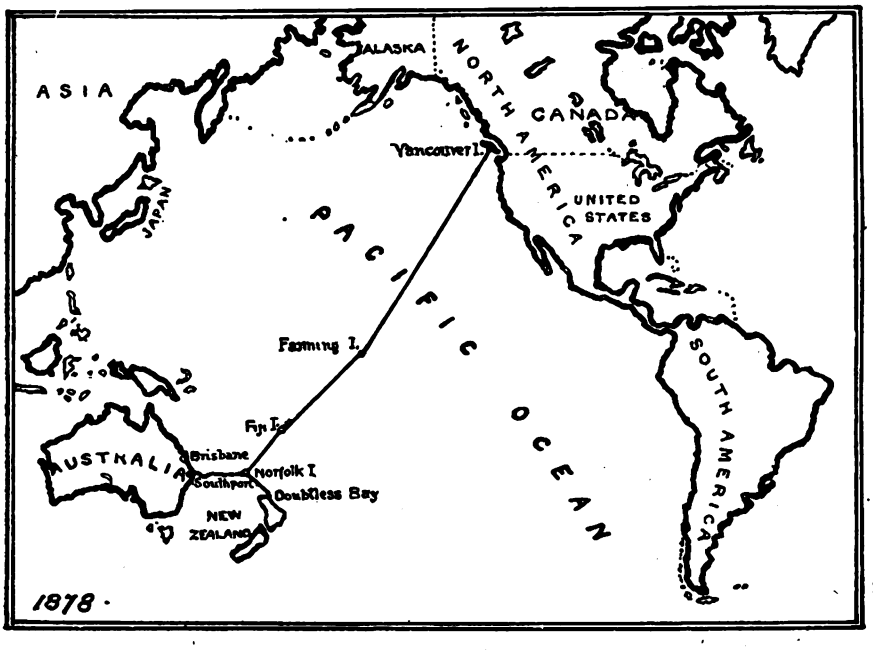
* Extracted from a paper read at Liverpool before the North Wales Centre of the Institute of Post Office Electrical Engineers.

Digitized by Google

Canada, two that of Australia, and one the Government of New Zealand.

The contract for the manufacture and laying of the cable was secured by the Telegraph Construction and Maintenance Company, whose tender was for about $1\frac{3}{4}$ million pounds.

The work was excellently carried out by the contractors, who completed their task fourteen months after the passing of the Pacific Cable Bill and some weeks ahead of time. 1 shows the route followed by the cable, which runs from Bamfield Creek, Vancouver Island, to Fanning Island, thence to the Fiji Islands and on to

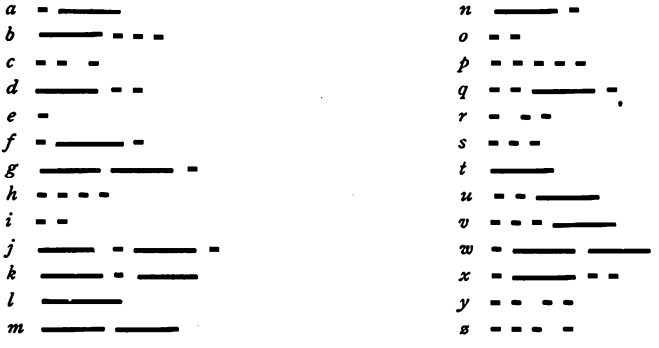


I.—Route of Pacific Cable.

Norfolk Island, from which point it divides to Australia and New Zealand. The section from Bamfield to Fanning Island is 3458 nautical miles in length, and is notable as being the greatest length of cable ever laid in one section. On this account the core had to be given a larger size than the other sections, the conductor being 600 lb. copper per naut made up of a solid central wire surrounded by four flat wires in a long lay and flattened down round the central wire. The weight of the G.P. dielectric is 340 lb. per naut. The cable was opened for traffic on December 8th, 1902, but unfortunately has not up till the present been a financial success, one of the contributing causes being that up till 1910 the transmission across Canada was undertaken by the Canadian Pacific Railway telegraph

Digitized by Google

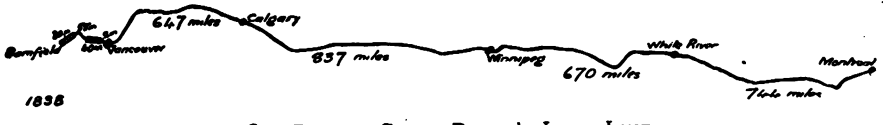
department, which uses the American Morse code. This code, as will be seen from 2, is peculiarly liable to introduce errors and consequent delay, and with a view to improving their service, the Pacific Cable Board about two years ago decided to lease a land line from the Canadian Pacific Railway Company to be worked with Wheatstone apparatus by their own staff. To assist in the training of this staff the Board applied to the Post Office for three officers on loan, of which party I had the privilege of being a member.



2.—American Morse Code.

3 shows the land line diagrammatically with the disposition of the different stations and the distances between them, the intermediate offices being all fitted with automatic repeating apparatus.

A description of Canadian practice in line construction was given in an article by Mr. Lakey in the Journal in July, 1911, and I need not trouble you with a repetition. The article mentioned the methods adopted to minimise inductive disturbance on the Cable Board's line by transposition, but whether they achieved their object



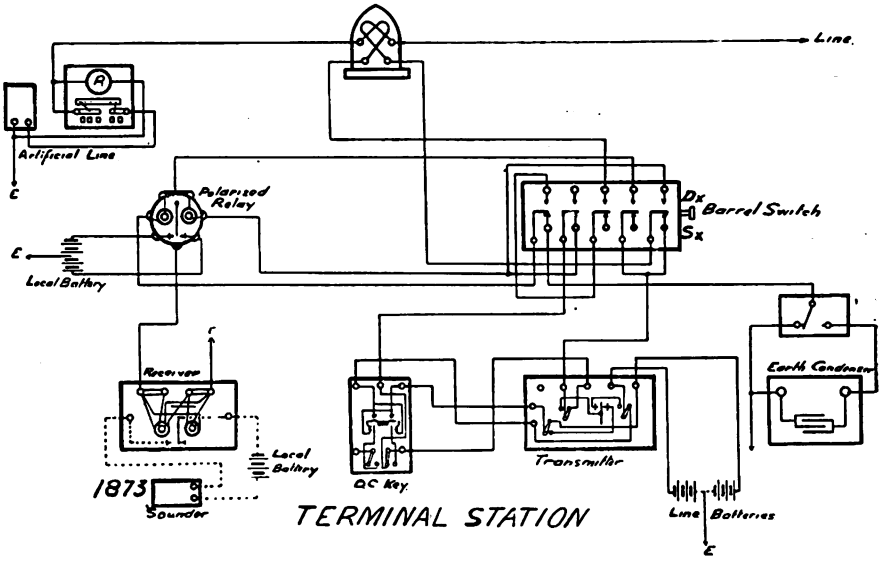
3.—Pacific Cable Board's Land Line.

is open to question. Interference from neighbouring circuits is abnormally great, as will be readily understood when it is said that the method of getting through and over trouble is to increase power until the desired end is attained, some quadruplex voltages being as high as 400, and so far as I could judge it made no difference whether we were working on our own line or one of the others, the disturbance was equally great.

4 is a diagram of the apparatus at the terminal offices, and shows that what is usually known as the opposition method of working has

Digitized by Google

been adopted, up and down offices being joined up alike, and using a negative current for spacing and a positive current for marking. This method is advantageous in one or two respects. There is no need to remember whether one is at an up or a down office with the relative changes in wiring, and where there are long idle duplex periods, as is the case with the Pacific Cable line owing to the difference of time between London and Australia, there is a considerable saving in line current. In our own service other advantages readily occur to one's mind which have been lost to us on account of what, I think, is a too slavish adherence to uniformity because of the requirements of minor omnibus circuits, many of which have now been converted to C.B. polarised sounder working.



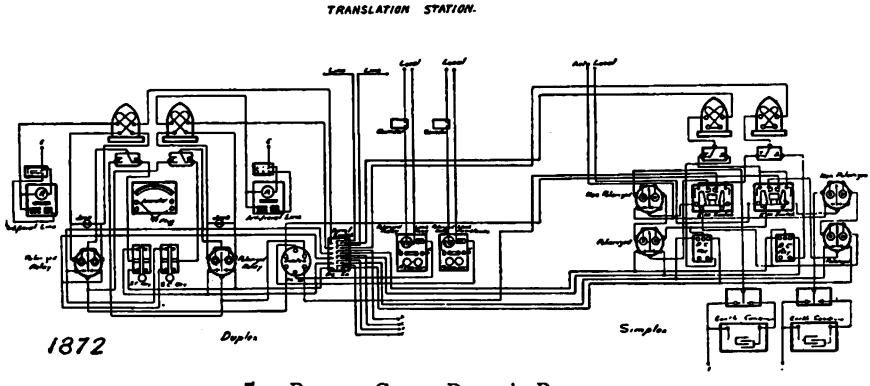
4.—Diagram of Terminal Station Apparatus.

The features of this diagram are the use of a barrel switch in place of the less costly 2-position 6-terminal switch; a D.C. key in place of a S.C. key with switch; a 2-way switch for interposing a 10 mfd. condenser between the receiving apparatus and earth during magnetic storms, which are very prevalent and frequently of great violence; the receiver, instead of being connected direct to line, is operated by the more sensitive standard relay, thus enabling the former to be worked with its coils in series when at duplex—a method which has long been recognised at our repeater stations as giving better results than the usual arrangement, and which might well be used to increase the output of difficult circuits.

5 shows the arrangement of the Pacific Cable Board's repeater.

Digitized by Google

It looks more formidable than our repeaters, but in a way is simpler, being really two repeaters side by side, one simplex and the other duplex, the two lines being connected to one or the other by means of the barrel switch, which also throws the repeating batteries with the lines. The outstanding feature here is the extraordinary number of switches, some of which might have been combined with advantage. The diagram shows an ammeter—actually a milammeter—on the duplex side, capable of being bridged across either relay by means of the plug and jacks for increasing the accuracy of the duplex balance. The inductive disturbances, however, rendered it quite valueless for the purpose for which it was supplied, and its use was abandoned after the first few attempts. Despite these disturbances it was our experience that the maintenance of balances was very much easier than on our mixed circuits in this country (the



5.—Pacific Cable Board's Repeater.

Canadian line is all open), and that but for earth current troubles the circuit might almost have taken care of itself.

The leak circuits show, in addition to the receivers, standard relays to operate the sounders, but such an arrangement, in the absence of spark condensers, for which there was no provision, seriously limits the speed value of these circuits, and the relays were cut out and the sounders joined to the receivers in the usual local circuit.

The leak resistances are of the dial pattern with radial arm. In addition to its cost this form of resistance box is particularly objectionable in this position, since with the arm at the zero and low resistance points the battery is short-circuited, resulting in the signals not being repeated. This may easily occur where there is an inexpert staff, and actually did take place at one of the repeater stations during the absence of the instructing officer.

On the simplex side the particular feature is the use of non-

Digitized by Google

polarised relays to operate the electro-magnetic switches instead of the usual neutral standard relays. They are similar to our non-polarised relays C, being wound to the same resistance, but have less bulky cores. I confess I felt some misgivings as to how non-polarised relays would behave, having been told some years ago that they were unsuitable for this purpose. As it turned out, however, they proved capable of maintaining communication at speeds considerably in excess of the standard of the section of line immediately under my observation, which had a length of about 750 miles.

I have recently had two N.P.C. relays on trial on a London–Llanfair length *viâ* Warrington of about 285 miles in length, and of the pair one proved quite useless and was obviously mechanically defective, the axle being much too sluggish on its pivots, which were very short. I should be very sorry for anyone afflicted with it on a quadruplex. The other was admirable, and proved equal to the maximum speed of which the London transmitter was capable—about 370 w.p.m.—with a shunted condenser of 8000 ohms plus 1·75 mfd. There was a discussion at one of our meetings some years ago on the relative merits of the two forms of neutral relay, when it was agreed that those fitted with flat springs were useless for high speeds on account of the bias inherent in this form of spring, and I would express the opinion that a non-polarised relay, though not so sensitive as the old spiral spring neutral relay, if manufactured with reasonable care, would, on account of its ease of adjustment, prove very suitable for all commercial speeds of working.

Referring again to the diagram (5), it will be seen that the connections to the electro-magnetic switches are somewhat different from the standard, and, with the leak circuit arrangement adopted, the back stops are left blank, the receivers being earthed direct instead of through these stops.

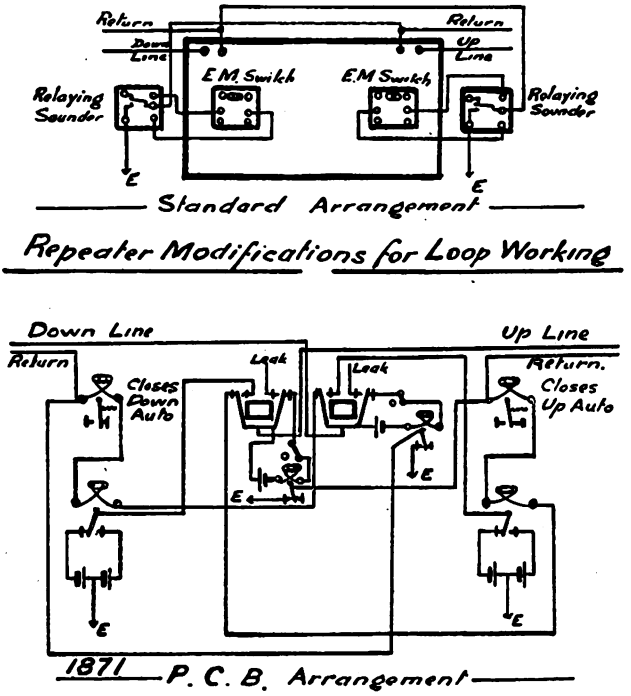
As at the terminal offices, so here we have 10 mfd. condensers fixed for working through earth currents, and it will be appropriate at this stage to say something about magnetic storms as experienced in Canada. During a three weeks' wait for the completion of the construction of the line after our arrival, we learned that a P.D. of 600 volts between terminals was no uncommon experience, and that nothing could be done but to sit down and await the passing of the disturbance. As events proved that was our experience also, despite our condensers, for on the very first day we opened for traffic three of these condensers were burnt out, much to the dismay of the Board's officers, who had hoped that they would be able to surmount any difficulty of this nature.

We naturally suggested that the original condensers should be

Digitized by Google

substituted by Mansbridge's self-sealing type, but it was thought that the latter, being so much smaller for the same capacity, could not be mechanically strong, an opinion with which I did not agree.

I very early formed the opinion that the condenser method of working for earth currents on a line with so many repeaters is comparatively useless. In this country it is our experience that with only one repeater in circuit it is difficult, even with experienced telegraphists, to prevent the automatic switches from opening at times, with consequent loss of signals. That being so you can readily understand that, with a plurality of repeaters, if the first



6.—Modifications for Loop Working.

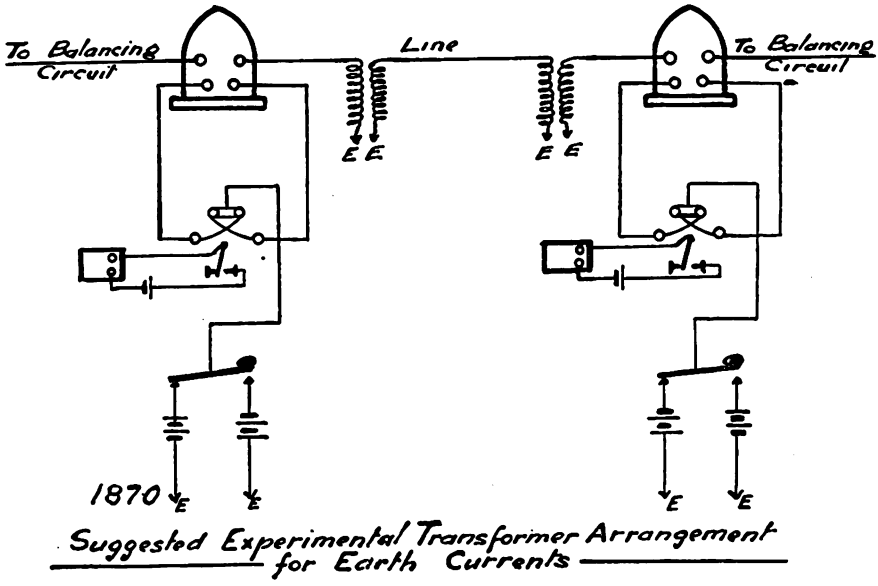
auto-switch breaks, all the others will, and if all are not exactly in step—a wholly fortuitous condition—the result is hopeless mutilation.

During our stay an experimental trial was made with a metallic loop, which, of course, is an effective method of dealing with earth currents. As you are aware, certain modifications are necessary where divided batteries are used, as is the case at repeater offices. The upper portion of 6 shows the Post Office arrangement for loop-working at these offices. The usual earth connections are cut off, and the return lines substituted, and in parallel with the auto-

Digitized by Google

switches are relaying sounders, which serve to earth the return-line of the pair, into which signals are being sent, so as to provide a circuit for the earthed batteries. A weakness of this arrangment is that no provision is made for speaking from the repeater, seeing that both hands are engaged on the keys, while at the same time it is necessary to earth both return lines. There should be a switch to short-circuit the tongues and contacts of the neutral relays, so that the relaying sounders may be closed.

In the Pacific Cable Board's arrangement the blank back stop of the auto-switch was utilised to close the circuit of a dry cell and a standard relay, the tongue of which was biassed so that when the



7.—Mr. Lockhart's Transformer Method of Eliminating Earth Current Trouble.

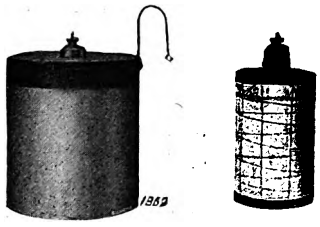
auto-switch closed the earth connected to the spacing stop of the standard relay was thrown on to the relative return line. The same object was attained when speaking from the repeater by opening the 2-way switches.

This experimental trial, being arranged for several days ahead, was quite satisfactory, but naturally did not include the condition to be combatted—earth currents. These usually appear during the night, and as all wires are put out of action the practical difficulty is to arrange which is to be appropriated for the loop, to say nothing of the scarcity of through transcontinental lines. The only way out is to lease a second line and work metallic circuit permanently, with its disadvantages of doubling the rental and liability to faults,

Digitized by Google

against which may be set the advantage of having two lines and being able to adopt single line working in the event of a stoppage on one.

In this country earth currents are comparatively infrequent, and with two or three exceptions have been successfully dealt with by the usual well-known methods, but in Canada the problem was so insistent that the idea was forced upon me that there might be another way out of the difficulty, and after my return I asked our Headquarters if it could be proved experimentally whether the arrangement shown in 7 would be of any value. It provides for a high-resistance transformer with equal windings at each end of the line, thus giving a free circuit for the earth current upon which the working currents would be superimposed. It is usually stated that condensers provide an effectual barrier to earth currents, but that this is not so is proved by the character of syphon recorder signals on submarine circuits, and if the currents are exceptionally strong they build up in the condensers sufficiently to stop communication



8.—Siemens' Sack Leclanché Cell.

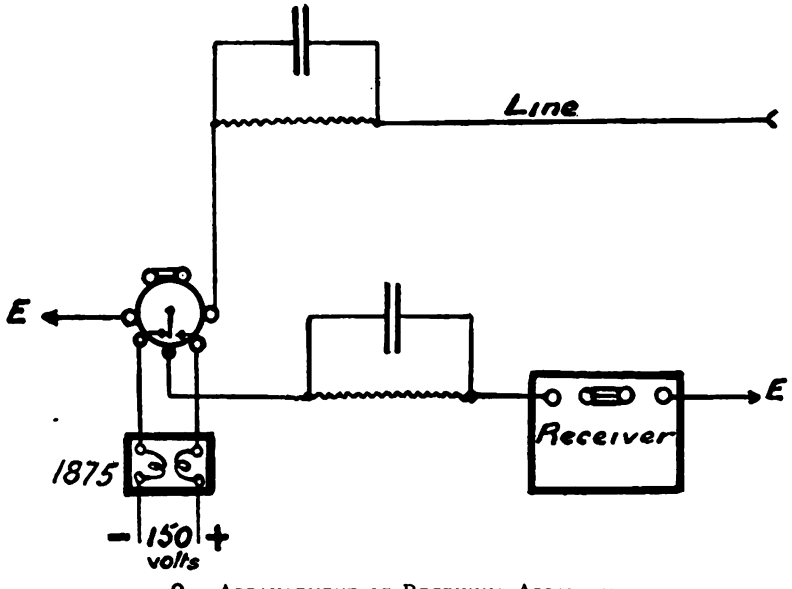
altogether, and sometimes set up surges which may burn them out, as we experienced.

The diagram shows the apparatus arranged for duplex in order to gain the advantage of the elimination of the repeater automatic switch difficulty which has been referred to, but it need not necessarily be duplex where there is no repeater in circuit.

The apparatus for the Canadian offices was supplied by Messrs. Siemens, and it goes without saying that its appearance and finish were excellent. All pivots were beautifully turned—an important desideratum in fast-speed working, and one which does not always get the attention it should. In one or two cases, however, bearings had been cut rather closely, and had to be remedied locally, so as to get the necessary end play. A neat device in the receivers enabled the governor to be easily taken out for cleaning and adjustment, the front bearing being in the centre of a disc which fits flush into the front plate, and is firmly held in position by the slip guiding platform. The pressure of the jewel spring is adjustable by means of two screws attached to a V-shaped piece.

Digitized by Google

Ample provision is made for protection from lightning, and we experienced several severe local thunderstorms without suffering any damage. The lines are led into the railway company's test-boxes, where, in common with others, they are fitted with small carbon protectors similar to our protectors D, which are just as unpopular with the Canadians as the latter are with those of us who have to handle them during thunderstorms. In addition, there is in the P.C.B. instrument room a large plate protector, supplemented by a brass bobbin with one turn of silk-covered wire, the ends of which are wound on adjusting screws to enable punctures in the insulation to be wound clear of the core.

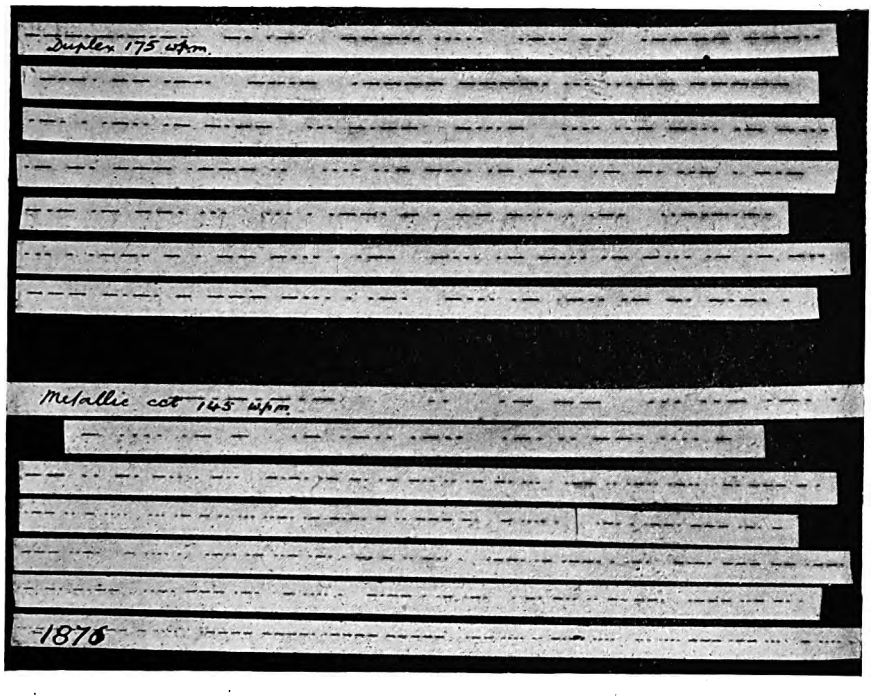


9.—Arrangement of Receiving Apparatus.

The power supply at the various offices calls for no comment, except in the case of White River. At the other offices power is obtained from the C.P.R., either from accumulators or direct from dynamos. At White River, where there was no power supply available, we had an extra large form of Sack Leclanché cells, supplied by Messrs. Siemens. The containing jar is larger than the department's usual largest size, so as to provide the necessary amount of electrolyte required for a heavy discharge. The zinc element is of the usual cylindrical shallow form. The negative or carbon element—shown to the right in 8—is made up of a special mixture moulded around a central carbon, and held in place by a wrapping of textile fabric. To prevent evaporation the cell is furnished with a closely fitting cover of paraffined wood.

Digitized by Google

It was a new experience to find Leclanché batteries supplied for use as line batteries for duplex Wheatstone working, and I anticipated a considerable amount of work in upkeep, and possible trouble in maintaining communication. As a matter of fact, during two months' constant night and day duplex we had absolutely no trouble, and beyond the usual periodical crossing of the marking and spacing batteries to equalise their discharges incurred no labour whatever. At the end of that time, when a re-distribution of stations enabled us to get all our power from the C.P.R., we found that so far as



10.—Wheatstone Slips at 175 and 145 Words per Minute.

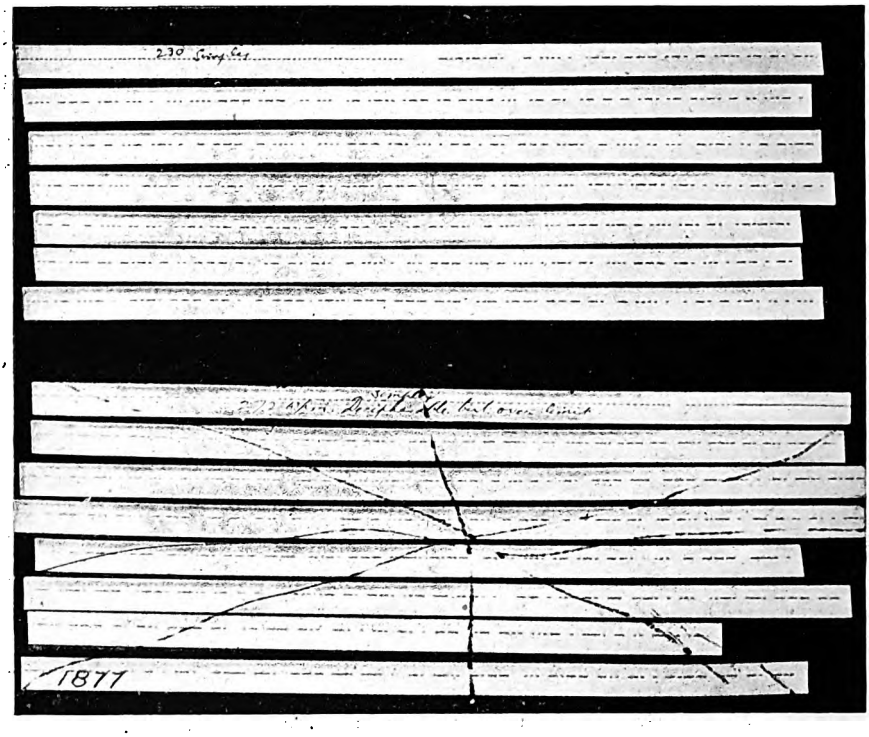
appearances went these cells might never have been in use. They were quite clean, and the consumption of zinc had been so even that it was only by comparison with a new plate that the difference in weight could be perceived. It is safe to say that a bichromate battery in similar service would have required a general clean-up and overhaul in less than half the time. A reference to Mr. J. G. Lucas's paper on the new types of Leclanché cell will provide further nformation on this subject.

No provision had been made for resistances in the power leads, and we had lamp resistances fitted with 2-way switches, which in one position put the lamps through to the batteries, and in the other

Digitized by Google

earthed them direct, thus saving the substituting resistances usually employed. This arrangement is sufficient with batteries of negligible resistance, and with the Leclanché batteries described, which had a resistance of about one-seventh of an ohm per cell, was quite satisfactory.

It would have been interesting to have been able to show what could be accomplished in the way of speeds on a 3000 mile line, but unfortunately, our stay was too short to permit of high-speed through trials. In the course of instruction given to the staff at White River,



II.—Wheatstone Slips at 230 and 272 Words per Minute.

however, we were able to get some very good speeds between that point and Montreal, a distance of about 750 miles, which is much longer than anything we have here.

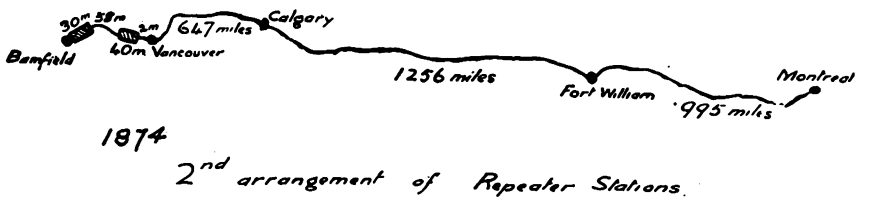
The receiving apparatus for these trials was arranged as shown in 9, the Cable Board's arrangement making no provision for shunted condensers. The speeds were built up gradually, beginning with their arrangement, which yielded 140 w.p.m. With the shunted condenser in the line we got 165 w.p.m., and with the addition of the condenser in the receiver circuit we were able to get 230 w.p.m. quite comfortably. 10 and 11 show specimens of the marks obtained,

Digitized by Google

and a close examination will show the slight distortions caused by the heavy inductive disturbances. In the metallic circuit trial the total length of wire was 1500 miles. These results were no doubt largely due to the exceptionally high insulation resistance, a condition easily attainable with the dry climate of Canada, an insulation test of a 1250-mile section of open line measuring practically infinity.

It is needless to say that in these trials the apparatus was carefully adjusted to its maximum sensitiveness, which it rarely is when received from the shops, and it is one of the great advantages of a training at an isolated repeater station that the staff have to study the characteristics of different pieces of apparatus of each class and find the best adjustment of each individual piece for their own protection, because when difficulty arises the first point of attack from both terminals will be the repeater office.

I have had no means of direct comparison of the results shown with anything on a similar line, but Mr. Murray, in a recent paper, gave some figures for an iron wire between St. Petersburg and Omsk



12.—The Pacific Cable Board's Land Line. Arrangement of Repeater Stations.

in Siberia. The length of this line is 2400 miles, and there are three repeaters, giving an average length of 600 miles per section. Reducing Mr. Murray's figures to the usual basis of five letters per word, he says that the output of the Murray was 72 to 78 w.p.m., while the Wheatstone speed is less than 48 w.p.m. These, presumably, are duplex speeds, and I cannot help thinking that the Wheatstone speed is the everyday working speed as against the Murray with highly skilled attention. The ingenuity of the Murray and other printing systems is worthy of the highest admiration, but in a genuine trial, with proper team working, I would still expect Wheatstone, with its single electro-magnet, to come out on top.

In view of the controversies, which have taken place from time to time as to what is the best colour for Morse paper, I would like to draw attention to the fact that we used white slip in Canada, and if I were asked to give an opinion on this point I would unhesitatingly pronounce in favour of white. The usual objection to this colour is that the glare is trying to the eye, but this can only be urged in the case of glazed paper, which would never be used for Morse slip.

Digitized by Google

The surface of white slip is flat and dull, and the marks stand out clearly and distinctly and are easily followed at the highest speeds. The advantage is more apparent in reverting to blue after using white for a time than in the first change from blue to white.

The present disposition of the repeaters on the Canadian land line is shown in 12. Our engagement by the P.C.B. was for three months, and six weeks of this had elapsed before the line was completed and opened for traffic, and we had hardly got well settled down to work when the Post Office was pressing for our return. It was recognised that it would be impossible to man the original number of repeater offices with any degree of efficiency, and it was decided to cut out one of them. Winnipeg and White River were accordingly closed, and a new office opened at Fort William. This reduced the speed of the line considerably, but it is still well above that of the cable, and should, no doubt, carry all the traffic with which the cable is capable of feeding it.

THE MURRAY PRINTING TELEGRAPH JOURNAL.

MR. DONALD MURRAY—well known to our readers—has recently returned from a business trip to America, and has just issued, after a two years' interval, No. 2 of his own particular Telegraph Journal.

Mr. Murray reports fully on the progress of printing telegraphy in the United States, and those who have read his previous publications will not need to be told that he does so in a specially interesting, logical and incisive manner. For the information of our readers we reproduce Mr. Murray's "Miscellaneous Notes."

ELECTRIC CONTACT MATERIALS.

One of the most interesting minor points noted during the trip was the extent to which silver is being used for contacts. The cost of platinum is so high that the employment of a cheap substitute is no longer a matter of indifference. Silver contacts are being used by both of the big telegraph companies in America and also by all the printing telegraph inventors, and the results appear to be satisfactory, in spite of the high voltages and heavy currents employed in telegraph practice in the United States. The French telegraph administration has used silver contacts for years. Silver has the advantage that the dirt on the contacts is a fairly good conductor; but silver is soft and much more easily fusible than platinum, and it is not unlikely that a more satisfactory contact metal or alloy would be discovered if some attention was devoted to the matter in telegraph laboratories. For instance, ductile tungsten appears to have special advantages for the purpose.

ELECTRO-MAGNETS FOR RELAYS.

Electro-magnets are being quite largely substituted for permanent magnets in telegraph relays in America. The P.O. standard design of relay is being generally used with an electro-magnet substituted for the permanent magnet. The Western Union officials state that they are using more of the electro-magnetic relays than permanent magnet relays, as

Digitized by Google

the electro-magnetic relays give less trouble. They find that, at any rate under American conditions, the permanent magnets are not permanent, especially with high-speed working, as the reversals tend to demagnetise the permanent magnets. Messrs. Bunnell & Co., large American manufacturers of telegraph instruments, are supplying P.O. standard relays fitted with electro-magnets in place of permanent magnets, the electro-magnets being neatly packed away in the form of a long thin coil behind the armature pivots. Electro-magnetic relays are used in the Morkrum system, and Mr. Wright, of the Wright printing telegraph system, also uses them. He says he gets better results with the electro-magnetic relays. In this connection also it may be mentioned that the Eastern Telegraph Company has been experimenting with electro-magnets in the Brown drum relay in place of the large permanent magnets hitherto used.

Style of Type for Printing Telegraphs and Typewriters.

In telegraph work in the United States plain block letter capitals are preferred, thus—A B C D. They are employed on the Morkrum, the Wright and other printers, and the Western Union is specifying this kind of type for the 10,000 Underwood typewriters that it has ordered. It is a good clear style of type, but the German system of using small letters (lower case) instead of capitals is undoubtedly the best from the point of view of legibility. I was informed in Berlin that the matter was carefully investigated by the German telegraph administration, the outcome being that small letters were found to be the best. The consequence is that now in all telegrams in Germany, even in the case of handwritten telegrams, only small letters and no capitals are employed.

The Edison Accumulator.

The commercial use of the Edison nickel accumulator is making rapid progress in the United States, and it is so durable and robust that it should be of interest to telegraph administrations. I went out to Orange, New Jersey, and was shown over the extensive and wonderfully equipped factory that has been built to manufacture the Edison accumulator. I also had the privilege of a chat with Mr. Edison. He and his associates have great confidence in the future of the Edison accumulator, and very large sums of money have been spent in equipping the factory with wonderfully intricate and ingenious machines and processes for the construction of the accumulator. In fact the whole secret of success in the case of this battery may be said to lie in the machinery and methods employed in its construction.

It is a circumstance not without significance that Edison, the foremost inventor of our time, is drawing his main revenue from popular amusements, that is to say from his phonograph and cinematograph film factories. Amusing people is more profitable than inventing printing telegraphs.

THE PRODUCTION AND RECORDING OF SLOW ELECTRICAL OSCILLATIONS.

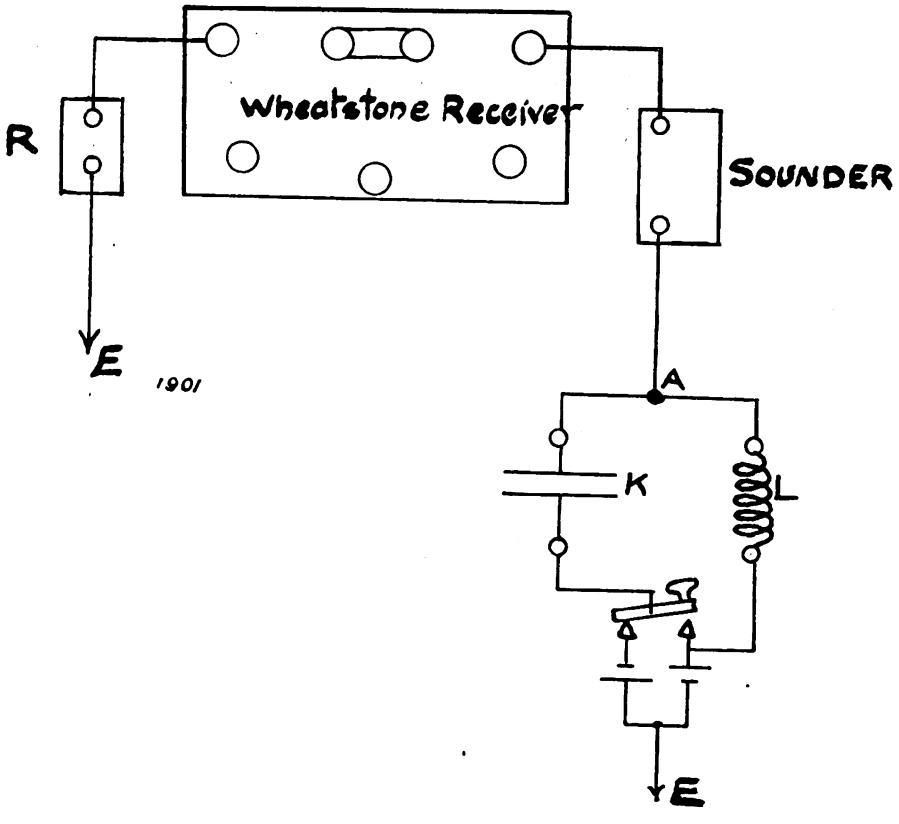
By Chas. E. Hay.

Electrical oscillations may be produced and recorded by means of ordinary telegraph apparatus joined up as shown in 1. A large inductance L having a very small resistance and a large capacity K are joined up so as to form an oscillating circuit. A Wheatstone receiver, a sounder 900$^{\omega}$ and a rheostat R are joined in series, from a point between the inductance and capacity, to earth for the purpose of obtaining a visual and acoustical record of the current

Digitized by Google

as it oscillates. The object of joining up the recording apparatus in this manner is in order that its resistance shall not be in the oscillating circuit. The current taken from the oscillating circuit should be just sufficient to operate the recording apparatus; the rheostat is provided for the purpose of this adjustment.

Normally the condenser is charged to the full potential of the double battery, and a small current is continuously flowing through the inductance, sounder and Wheatstone receiver. This current

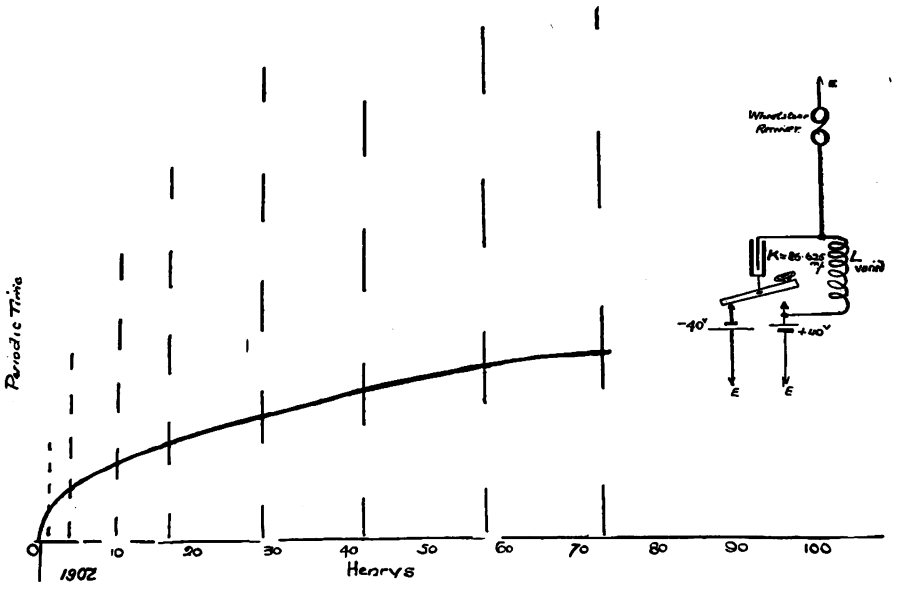


I.—Oscillations Produced and Recorded by Ordinary Telegraph Apparatus.

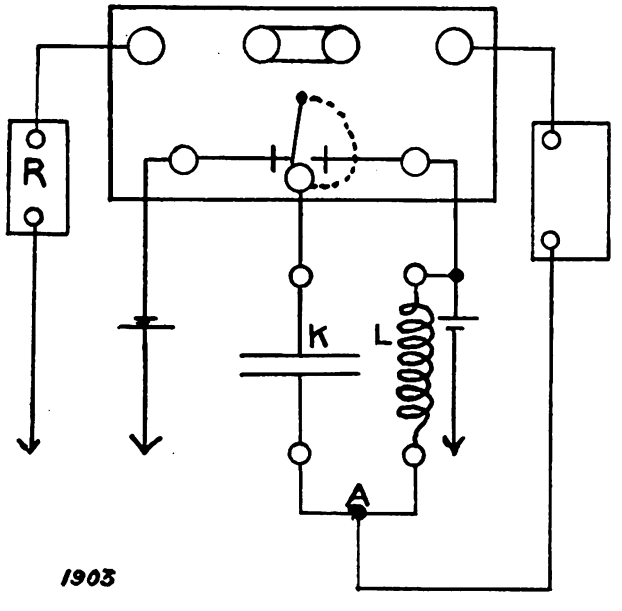
polarises the sounder and renders it sensitive to weak currents. On depressing the key the condenser discharges and oscillations are set up in the circuit L—K having a definite periodic time depending upon the value of L and K, the resistance of the inductance being so small as to be negligible. The potential at the point A is therefore oscillating, and current due to it is sent through the recording apparatus operating the sounder and the receiver.

Results taken on slip of a circuit oscillating at different frequencies as a result of varying the inductance are shown in 2. The

Digitized by Google



2.—Records, on Wheatstone Slips, of Oscillations at Different Frequencies.



3.—Method of Producing Persistent Oscillations.

Digitized by Google

magnitude of the capacity and inductance used is shown on the diagram. Of course each of these results was obtained from one depression of the key. By drawing a curve through the middle points of corresponding signals the variation of periodic time with inductance can be seen. In every case this agreed with the theoretical value:

$$T = 2\pi\sqrt{LK}.$$

By using a very large inductance it was possible to obtain no less than thirteen signals from one depression of the key and these followed each other at about half-second intervals.

By causing the receiver itself to open and close the oscillating circuit as shown in 3, the oscillations can be made to persist after having once been started. In this case the number of signals recorded on the tape per minute will be found constant for a definite value of L and K, and the frequency of the oscillating circuit can thus be experimentally determined.

Digitized by Google

ON DISPENSING WITH ANTENNÆ IN WIRELESS TELEGRAPHY.

By L. ZEHNDER.

Translated by H. HARTNELL, A.M.I.E.E.

STEINHEIL, who, at the suggestion of Gauss (1838), used the earth instead of a return wire for telegraphic currents transmitted through a conducting wire, showed in connection with these experiments that it was possible to transmit electrical effects through the earth within certain limits wholly without wires, the electricity being diffused through the earth. He succeeded in working in this way through distances up to 50 ft.[1]*

The first experiments in real wireless telegraphy, exclusively with currents through the earth, and without the use of a conducting wire from station to station, were apparently carried out by Morse. By means of an earthed transmitting wire stretched horizontally along the bank of a river and having its ends connected with the water by metal plates (1) he transmitted signals across the river, using direct currents (1842). The signals were received on a similar parallel wire erected on the other side of the river and read on a sensitive galvanometer.[2]

Morse ascribed the effect to the diffusion of the current through the conducting mass of the earth, and he found in later experiments that the conductors should be about three times as long as the space through which the signals were to be transmitted. A similar method of telegraphing across a river without wires was proposed by Wilkins in 1845.[3]

Trowbridge, in 1880, regularly transmitted time signals from a wire at his observatory, Cambridge (U.S.), to a conductor about 1·6 km. distant.[4] Preece increased the range to about 8 km.

* The index figures refer to reference notes at the end of Prof. Zehnder's article.

Digitized by Google

(1884 to 1893) with alternating currents in the transmitting wire and a telephone in the receiving wire[5], and attributed his success chiefly to inductive action through the air.

At the instance of the Imperial Navy Department W. and E. Rathenau and H. Rubens[6], in 1894, made experiments in the Wannsee, near Berlin, using rapidly intermittent currents (150 periods) and a telephone receiver, and were able to transmit signals to a distance of 4½ km. They could have attained a still greater range if a stronger current than 3 ampères and a higher periodicity had been available. A little later (1894 to 1896), Strecker[7], with a similar arrangement on land, transmitted signals both with intermittent currents and alternating currents of 50 periods. With a primary conductor 3 km. long and a secondary 1·2 km. long he attained, with a current of 14 to 19 ampères, a distance of 17 km.

In his first experiments (1896), Marconi, also for *receiving*, connected his coherer on each side with one of the plates of a condenser, the other side plate of which was to earth, the earths being placed "preferably at a certain distance"[8] (2). The receiving wire had to be laid in the direction of the transmitter.

Similar arrangements to Marconi's were used by Braun in his experiments in the water of the ditch of a fortress at Strasburg both for *sending* and *receiving*, and in 1898, by the addition of his well-known oscillation circuit, consisting of a spark-gap F, capacity C and self-induction L (3, 4 and 5), with an induction coil giving on a 10 cm. spark, he succeeded in working to a distance of 1·6 km. along the Rhine, when the transmitting and receiving lines were approximately in the same straight line and the earth connections were placed 80 m. apart. On the sea he soon afterwards obtained a range of 3 km.[9]

Like Preece and Strecker, Braun with his arrangement produced by means of his transmitter alternating potentials of opposite phase at the two earths; like Marconi, he picked up alternating potentials with his receiver. So far as I am aware, however, neither of these investigators mentioned in connection with the experiments referred to the principle of interference (Interferenzprinzip) or consciously applied it, in the sense that a certain definite distance between the earths must give the *best* results. Lecher[10] called attention to this point (January, March, 1903) by proposing to lay on the ground two large horizontal metal plates at a distance apart of half a wave-length of the frequency used and in the direction of the incoming waves; a horizontal wire connecting these plates would then be traversed by corresponding electric oscillations. Hence it would be possible with this arrangement to determine the direction of the sender (6; Lecher himself does not give a figure).

Lecher's arrangement has, however, an element of indefiniteness,

Digitized by Google

namely the metal plates simply laid on the ground. The incoming oscillations may in fact form in the plates either loops of potential if there is no conductance between them and earth, or nodes of potential if this conductance is on the contrary very good. In certain circumstances, however, sometimes the one and sometimes the other of these cases might occur—in changeable weather for example. This arrangement was, moreover, only suggested by Lecher for the *receiver*; for the transmitter the method would be less suitable, and tuning to a given wave-length still more difficult.

Almost simultaneously with Lecher I also had in view the application of the interference principle in the case of directed wireless telegraphy, and, in fact, intended to apply the principle to both the sender and the receiver. I made some transmission experiments in this direction at Munich in December, 1902, using intermittent currents of a frequency of about 1000. Then I proposed to the Imperial Navy Department (January, 1903) the application of the interference principle in directed wireless telegraphy, using two transmitting antennæ s_1 s_2 of equal oscillation period and placed at a distance of half a wave-length apart (7). To the same Department I proposed (July, 1903) a system of wireless telegraphy on the interference principle with earth currents (8), using two earths $\frac{\lambda}{2}$ apart. In this system I had in view the employment of a high-frequency machine. For this arrangement I applied for patents[11] in which I still laid special stress on the fact that the earths might be replaced by condensers c, the other plates of which were earthed (9). Later[12] I called special attention to the necessity of taking into account in calculating the distance apart of the earths, the large index of refraction of the earth for electric waves (2 to 9), that further condensers might be inserted to artificially increase the effective length of the conductor, and that, moreover, the arrangement could be duplicated. In a further patent application (October, 1905) I combined the arrangements of my earlier patents with the Braun oscillation circuit and with the, at that time, prevailing systems of spark telegraphy.

An application (accompanied by all my patent specifications) to the Imperial Post Office in 1905 to be granted the means of carrying out experiments in accordance with the systems above described unfortunately had not the desired result; also the Wireless Telegraph Companies to whom I applied showed no interest in my new system.

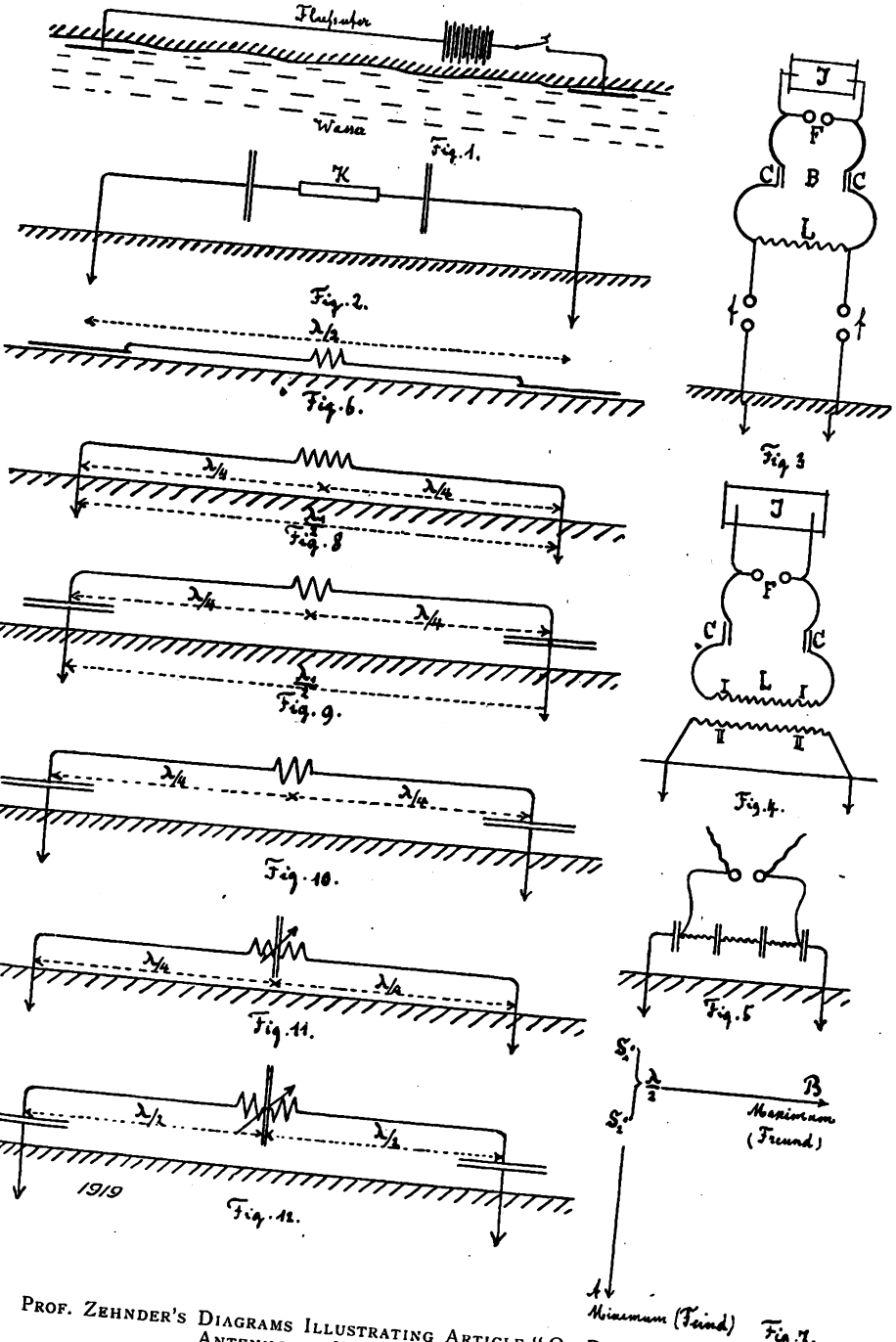
But recently (1910–1911), experiments have been carried out by the Imperial Post Office (Telegraph Research Branch) with systems (10, 11, 12) which were described many years ago in my patent specifications referred to above, and in these experiments

Digitized by Google

some of the results obtained were exceedingly good—the reception, for example, of signals from Canada nearly up to Berlin.[13] Thereupon Marconi[14] and I[15] established our claims to priority in the methods used by Kiebitz in these experiments. But, so far as I am aware, Marconi had never mentioned the principle of interference, upon which, however, success entirely depends. Unless the earths are placed at the right distance apart the effects may fall almost to zero. As a matter of fact, Kiebitz worked with the methods already described in my patents. In his latest experiments he inserted a condenser in the middle of his conductors. As mentioned above, I had, however, already called attention in my Austrian patent to the further insertion of condensers. It is also self-evident that Kiebitz's "earth antennæ," as he calls the horizontal conducting wires (already used elsewhere or proposed to be used) will oscillate in half or whole wave-lengths; this follows from the well-known action of condensers and earths. In some of his experiments Kiebitz also worked with wires which had neither condensers nor earth at their ends, and which were simply thrown on the ground. This, however, was the arrangement first proposed by Lecher if we leave out his large metal plates so that the ends of the wires replace the Lecher plates. No new methods were therefore used in the above-mentioned experiments of Kiebitz. On the contrary, all these arrangements were proposed by me; the last-named, that of the wires simply laid on the ground, had, however, already been suggested by Lecher. It must be recognised that these systems, under the direction of Kiebitz, have been strikingly successful.

What, however, was unnoticed in Kiebitz's experiments, or at least not mentioned in the published papers, is the agreement of the distance between the two earths with the half wave-length $\frac{\lambda_1}{2}$ which I postulated. This wave-length λ_1 corresponds to an index of refraction in the earth for electric waves of about $n = 2$ to 2·5. For in these experiments it was found that with a distance between the earths of $\frac{\lambda_1}{2} = 240$ to 300 metres the most favourable wave-range for receiving was $\lambda = 1000$ to 1500 metres, which gives for the index of refraction about $\frac{\lambda}{\lambda_1} = n = 2$ to 2·5. Moreover, signals were received at Belzig, near Berlin, from Glace Bay, Canada, with a distance between the earths of $\frac{\lambda_1}{2} = 1270$ metres with wave-lengths $\lambda = 5800$ to 6000 metres, so that in this case $\frac{\lambda}{\lambda_1} = n = 2{\cdot}3$ to 2·4, in complete agreement with my hypothesis. Transmission experi-

Digitized by Google



PROF. ZEHNDER'S DIAGRAMS ILLUSTRATING ARTICLE "ON DISPENSING WITH ANTENNÆ IN WIRELESS TELEGRAPHY."

1.—MORSE'S METHOD OF WIRELESS TELEGRAPHY ACROSS A RIVER (1842).

2.—MARCONI'S ARRANGEMENT OF COHERER AND CONDENSERS FOR RECEIVING (1896).

3, 4, 5.—BRAUN'S ARRANGEMENTS AT STRASBURG (1898).

6.—LECHER'S HORIZONTAL METAL PLATES.

7, 8, 9.—PROF. ZEHNDER'S APPLICATION OF INTERFERENCE PRINCIPLE.

10, 11, 12.—EXPERIMENTAL SYSTEMS OF GERMAN IMPERIAL POST OFFICE (TELEGRAPH RESEARCH BRANCH).

Digitized by Google

Digitized by Google

ments under the conditions here laid down for receiving gave good signals; under other conditions the signals were bad.

The chief object of my proposals was to attain a greater range of transmission and also greater secrecy for telegrams by the introduction of directed telegraphy. In the latter object, the maintenance of secrecy, the secret code which I have devised is applicable. If we take any given cypher obtained by a definite transposition of the letters of the alphabet it is well known that this may always be deciphered by counting the signs, for we know precisely in what order of frequency the letters occur. But now let this transposed alphabet be changed either after each line of a given number of letters or even after each word by a simple displacement of the two alphabets with respect to each other as shown below;

a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*k*	*l*	*m*	*n*	*o*	*p*
u	*t*	*s*	*n*	*e*	*i*	*r*	*a*	*h*	*c*	*b*	*d*	*m*	*g*	*o*
t	*s*	*n*	*e*	*i*	*r*	*a*	*h*	*c*	*b*	*d*	*m*	*g*	*o*	*l*
s	*n*	*e*	*i*	*r*	*a*	*h*	*c*	*b*	*d*	*m*	*g*	*o*	*l*	*f*

and so on. Then each letter will appear with equal frequency and decipherment is now hardly possible. Such displacements may be automatically effected in the simplest way possible with certain well-known typewriters—the Blickensderer for example. The cypher can be made absolutely undecipherable without the key by interchanging several of such secret alphabets in regular sequence. By means of typewriters such interchanges can be very easily effected.

The decipherment of a received code telegram or letter can, of course, be effected by the same typewriter by displacing the alphabets in the reverse direction.

References.

(1) Righi u. Dessau.—'Telegraphie ohn Draht,' S. 306, 1907, Braunschweig.
(2) *Ibid.*, S. 307.
(3) *Ibid.*, p. 308.
(4) *Ibid.*, p. 319.
(5) *Ibid.*, p. 322.
(6) E. Rathenau.—'Elektrotechn. Zeitschr.,' Bd. xv, 1894, S. 616.
(7) Strecker.—*Ibid.*, Bd. xvii, S. 106, 1896.
(8) Marconi.—Pat. No. 12039; 'Electrician,' vol. lxviii, 1912, p. 936.
(9) Braun.—'Drahtlose Telegraphie durch Wasser und Luft,' S. 26, 28, 30; Leipzig, 1901.
(10) Lecher.—'Physikal. Zeitschr.,' Bd. iv, 1903, S. 320.
(11) Zehnder.—Engl. Patent No. 10601, May, 1905; French Patent No. 354408. May, 1905.
(12) Zehnder.—Österreich, Pat. No. 26404, May, 1905.
(13) Kiebitz.—'Ann. d. Phys.' (4), Bd. xxxii, S. 968, 1910; 'Verhandl. d. D. physik Gesellsch.,' Bd. xiii, 1911, S. 876.
(14) Marconi.—'Electrician,' vol. lxviii, 1912, p. 936.
(15) Zehnder.—'Elektrotech. Zeitschr.,' Bd. xxxii, 1911, S. 1101, 1195, 1219; 'Verhandl. d. D. physik. Gesellsch.,' Bd. xiii, 1911, S. 874, 1059.

Digitized by Google

THE DESICCATION OF PAPER-INSULATED CABLES IN SITU.

By G. F. MANSBRIDGE, M.I.E.E.

THE article on "Desiccators" by Mr. J. G. Hines in the October number of the JOURNAL reminds me of some experiments which were made in 1905 at the General Factory on behalf of the Engineer-in-Chief in connection with the desiccation of small paper-insulated cables. As the results proved instructive a note upon them may be of general interest, especially as but little has been published on the subject.

The primary object of the experiments was to obtain data in regard to the desiccation of 7-pair cables; consequently the tests were confined to that type of cable.

It was understood in the first place that no precise data were in existence in regard to the quantity of air that could be forced through a cable of a given type and length under a given pressure, so that before attempting to obtain any quantitative results as regards desiccation, it was thought well to obtain fundamental data as to the conditions determining the flow of air through the half-mile length of 7-pair cable upon which desiccating experiments were to be conducted.

It was soon found out that the air flux through this half mile of cable was so small as to render commercial instruments, as used for measuring small currents of coal gas, of no avail. Consequently the observations of air-flux were made by delivering the air into a glass jar of known capacity as in a pneumatic trough. The gas instruments for measuring pressure were also insufficiently sensitive for many of the purposes required; recourse was, therefore, had to U-tubes filled with water or mercury, and all the low-pressure observations were taken with these simple gauges, ordinary pressure gauges being used for the higher pressures.

The first necessity towards obtaining quantitative results was to settle upon definite units, and as a convenient basis arbitrary units were evolved and made use of. These were:

Unit of pressure	1 lb. per square inch.
Unit of current	1 cu. ft. at atmospheric pressure per hour.
Unit of resistance	Such a value as to satisfy the equation:

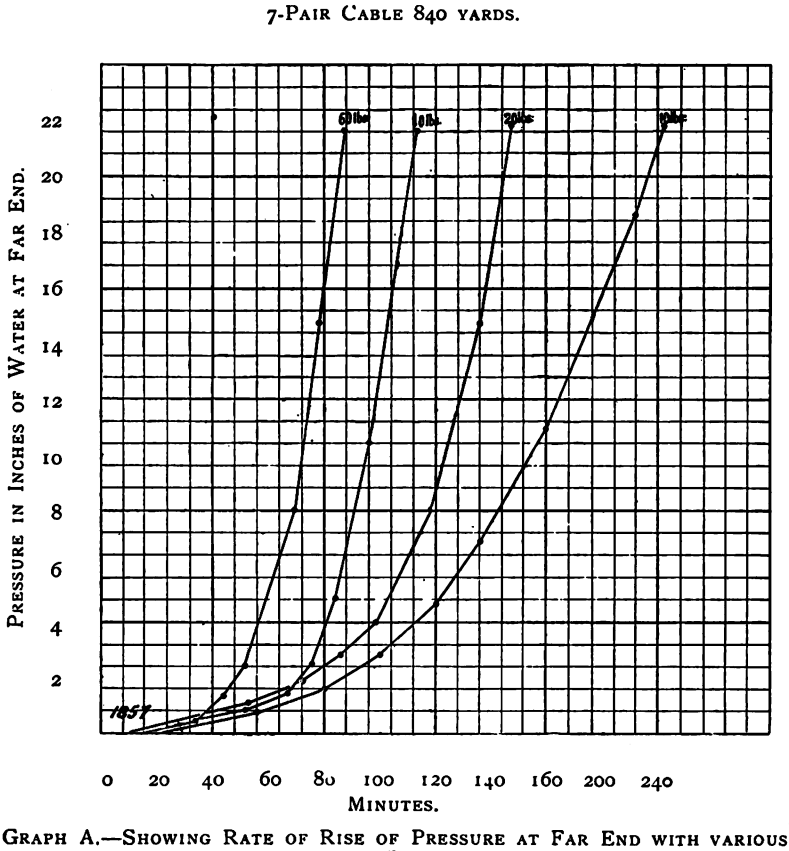
$$\text{Unit current} = \frac{\text{Unit pressure}}{\text{Unit resistance.}}$$

(*Note.*—The temperature remained approximately constant at about 60° F. throughout the experiments, so that no corrections for the small variations were considered necessary.)

Digitized by Google

The first measurements made showed how extremely small was the air-flux under ordinary pressures (say 20 lb. above atmosphere), and, therefore, how important it was to have all joints perfectly sound, otherwise the air rapidly leaked away, and the results of the experiments were vitiated.

After the joints had been proved sound the resistance of the cable was ascertained by measuring the flux at one end when a known constant pressure was applied at the other end. Observations



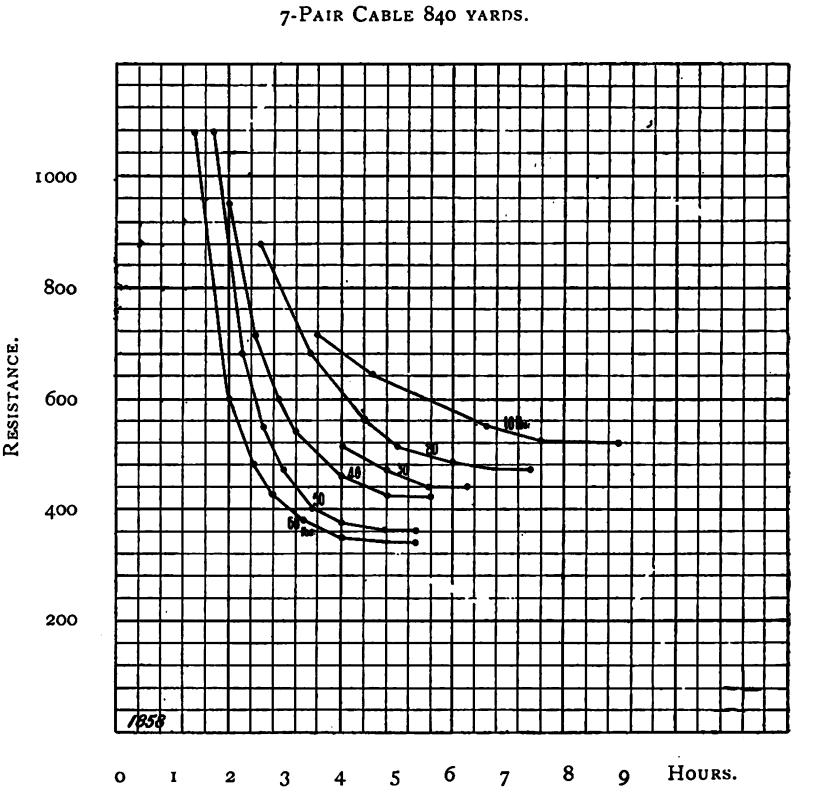
Graph A.—Showing Rate of Rise of Pressure at Far End with various applied Pressures.

were also taken of the time required for the pressure to reach the distant end, as well as of the rate at which the pressure rose when that end was sealed (by a water tube); the rate at which the current increased when the end was opened was likewise observed.

From these experiments it was found that if pressure was applied to one end of the length of 840 yards of 7-pair cable, some considerable interval elapsed before any rise of pressure was observable at the other end. Naturally, the greater the applied pressure, the

Digitized by Google

shorter the interval, but, even with 60 lb. applied, fifteen minutes elapsed before any rise in pressure could be detected at the distant end, and after an hour from the start the pressure at the far end amounted to only about 1 inch of water. During the second hour, however, the pressure rapidly rose, and by the end of that hour the air was beginning to arrive at a measurable, though still microscopic rate.



Graph B.—Showing Final Resistance of Cable with Various Applied Pressures, and Lapse of Time before Resistance reached Steady Value.

The results obtained with various pressures are shown on graph "A."

As soon as a measurable quantity of air had arrived it became possible to calculate the resistance of the cable, and, as might be expected, the apparent resistance, which at first was very high, steadily fell until it reached a constant value, this value being, of course, that obtained when the flux no longer continued to increase.

The intermediate and the steady values of the resistances are plotted on graph "B," from which it will be seen that a period of some five to seven hours elapsed before the resistance, and therefore

Digitized by Google

the current, became constant. Naturally, again, the higher the applied pressure the more quickly was the constant state attained.

The determinations of resistance were carried out on the cable as a whole, and also on the two parts into which the cable had been, in effect, divided by the insertion of a testing sleeve at about the middle point.

From the results obtained it became possible to deduce the laws connecting—

Pressure and current (with length constant).

Length and current (with pressure constant).

Current and pressure (with length varied).

It was found that these laws differ altogether from those governing the flow of air in pipes having little obstruction, such as pneumatic tubes.

To take first the relations between pressure and flux. These are:

In a pneumatic tube, flux $\propto \sqrt{P}$

In a tightly packed cable, flux $\propto \sqrt{P^3}$

or, expressing the same thing in terms of resistance, the relation becomes:

In a pneumatic tube, flux $\propto \frac{I}{L^{\cdot 5}}$

In a tightly packed cable, flux $\propto \frac{I}{L^{1\cdot 1}}$

Taking next the relations between flux and length, these are:

In a pneumatic tube, flux $\propto \frac{I}{L^{\cdot 5}}$

In a tightly packed cable, flux $\propto \frac{I}{L^{1\cdot 1}}$

Combining these relations we get the following:

In a pneumatic tube, flux $\propto \frac{P^{\cdot 5}}{L^{\cdot 5}}$ or $\frac{\sqrt{P}}{L}$

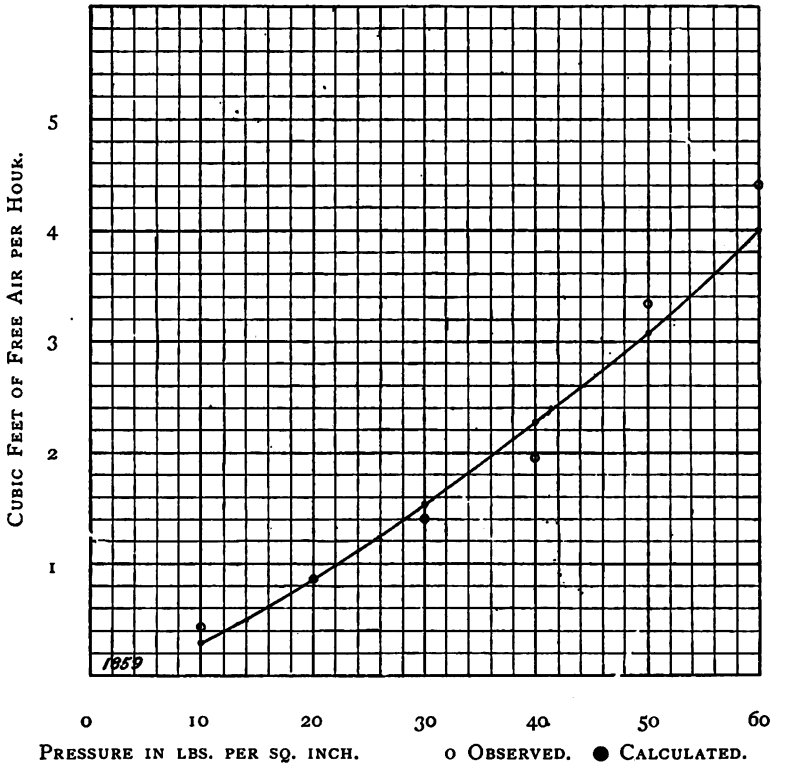
In a tightly packed cable, flux $\propto \frac{P^{1\cdot 5}}{L^{1\cdot 1}}$ or $\frac{\sqrt{P^3}}{L^{1\cdot 1}}$.

In the above calculations the pneumatic tube formulæ were taken from Kempe's 'Engineer's Year Book,' it being well understood, however, that the relations are not absolute but a close approximation.

As showing the closeness with which the observed values agree with those derived from the empirical formula deduced above, graph "C" has been prepared, on which the observed values of the flux are plotted side by side with the curve applicable to the cable in question, as calculated from the evolved formula, *i. e.* the flux being proportional to the square root of the cube of the pressure. It will be seen that within the limits of experimental error the observed values agree very fairly with those calculated.

Digitized by Google

Graph "D" shows how closely the relation between the resistance and the length approximates to the empirical formula $R \propto L^{1.1}$ so far as regards the particular cable tested. The exponent 1·1 is only an approximation, and it would probably have a different value for other types of cable, the closeness of the packing being apparently the determining factor. For the 7-pair cable tested the exponent has a higher value when the cable is drummed than when laid out straight. The value 1·1 refers to the cable when laid out.



Graph C.—Showing Flux as calculated from the Empirical Formula $F \propto \sqrt{P^3}$, and as observed on Half Mile 7-pair Cable (tightly packed).

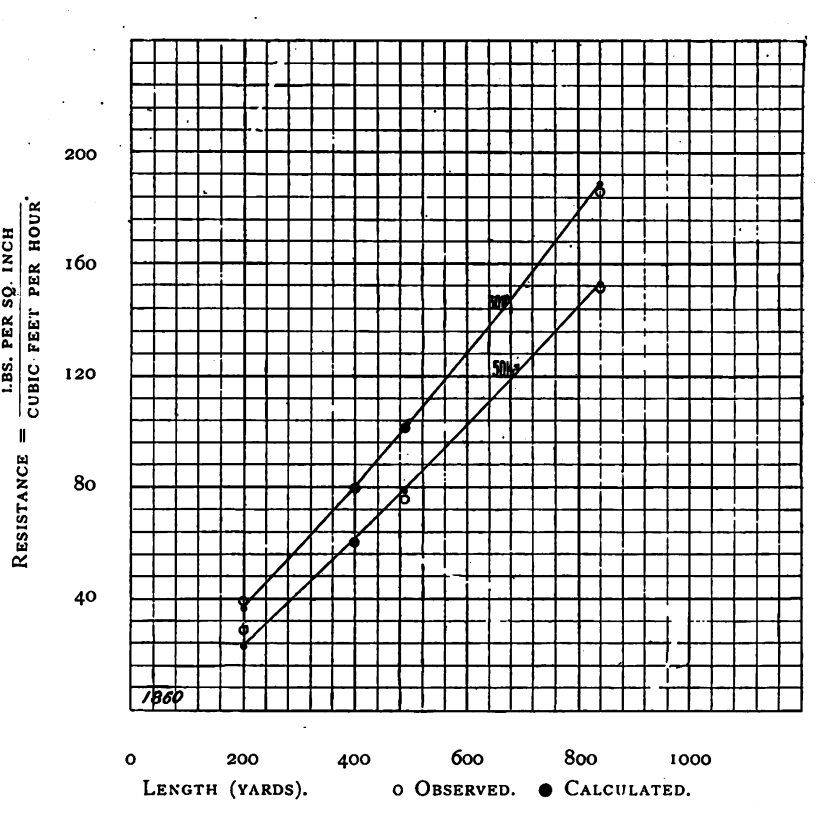
In this connection it should be remarked that the cores of small distribution cables are more tightly packed than is the case with main cables, so that discrimination is necessary before some of the results obtained with 7-pair cable are applied to cables of more open character.

The general results show clearly that a great advantage is to be obtained from the use of high pressures, and, inasmuch as the flux through even a quarter of a mile of cable under a pressure of, say,

Digitized by Google

60 lb. to the square inch, is only a fraction of a cubic foot per hour, it would seem that an economical method of drying such cables would be to compress desiccated air to a considerable extent into a suitable container, and then to connect such container (through a suitable reducing valve if necessary) to the cable under treatment, re-charging the container from time to time as occasion may require or convenience suit.

A point of importance in this connection is the maximum



Graph D.—Showing that for the Particular Cable Tested $R \propto L^{1\cdot1}$.

pressure which may safely be put upon the cable, and to determine this some short scrap lengths of 7-pair cable were tested, and the bursting pressure was found to be as high as 575 lb. per square inch. In these tests, however, the pressure was not raised so slowly as to permit the lead to "flow"; it is probable, therefore, that a lower pressure applied for many hours would have sufficed to burst the cable.

Two samples of 7-pair cable burst at 575 lb., and a third at

Digitized by Google

600 lb. per square inch, and approximately the same breakdown value was obtained from some odd lengths of cable of greater diameter, the larger area of the sheathing in the bigger cables being balanced by the greater thickness of the lead.

As regards actual desiccation, the 7-pair cable when first tested contained a very small quantity of water, and no difficulty was experienced in drying this out to an insulation of 5000 megohms per mile; it was then necessary to determine whether such desiccation would be possible if some yards of the cable were thoroughly saturated.

Experiments showed that if the quantity of water, although small, was sufficient to saturate even a few inches of the cable, the drying by low-pressure air (20 to 40 lb. per square inch) became extremely tedious, and for street work impracticable.

In one experiment half an ounce of water was introduced at the middle of the 840 yards of 7-pair cable; this point was then sealed and dry air at a pressure of 30 lb. was applied at one end, the other end being left open. The case thus presented was a somewhat difficult one, because the desiccation involved carrying the half ounce of water throughout a quarter of a mile of cable to the far end. It was found that continuous blowing for 387 hours was necessary before the "full earth" disappeared. From that time the insulation steadily rose, but even after 487 hours the insulation had reached only 14 megohms per mile.

It was evident, therefore, that it was hopeless to attempt to deal with such a case in the streets, but it was thought well to confirm the results by testing a length of cable of another firm's make, which at the time happened to be available.

This second cable proved to be of a much more open character than the first, for the flux measurements showed that the mechanical resistance to the passage of air was only about one sixth that of the original cable.

The fresh cable was therefore tested in two ways: (*a*) by inserting half an ounce of water in the middle and applying dry air at both ends simultaneously; and (*b*) by inserting half an ounce of water at the middle and drying it out as in the case of the original cable.

In the first experiment the results were fairly satisfactory, since the fault was removed and the cable dried after 28 hours' application of the pressure; but in the second case, when half an ounce of water had to be driven through a quarter of a mile of cable, the "full earth" was not removed until after 203 hours' blowing, and after 487 hours the insulation had reached only 980 megohms per mile. Since half an ounce of water cannot be considered a large quantity, there seems little doubt that in the event of a 7-pair cable being saturated for some yards, drying in the streets is almost hopeless,

Digitized by Google

except, perhaps, in those cases where the core is of a very open character.

Particulars of the 840 yards of cable on which the experiments were chiefly made are :

Bore of cable, 0·38 in.

Weight of copper per yard run, 0·165 lb.

Weight of paper and cotton per yard run, 0·054 lb.

Similar tests with cables of larger size could be made with even less difficulty than was experienced with 7-pair cables, and it would seem, therefore, that it would be an easy matter to make a fairly exhaustive study of the problem, in order to obtain sufficient data for practical use in those cases where cables have to be dried out from a distance.

In this connection reference may be made to the researches of Signor G. Palazzolo on the velocity of the flow of air in paper-insulated cables (ref., 'Science Abstracts,' 1185, 1909). From experiments conducted upon cables ranging from 100 to 1000 metres long, and with pressures of 1·2 and 3 kgrm. per sq. cm., it was deduced that the time required for the air current to pass varied directly as the square of the length of the cable, and inversely as the simple pressure.

Digitized by Google

USES OF MOTOR VEHICLES BY THE NEW YORK TELEPHONE COMPANY.

It was nine years ago that the New York Telephone Co. first began to use commercial motor vehicles. Five years ago the first gasolene truck was acquired, and proved so satisfactory for the work required that all subsequent purchases have been of this type, and the large electric vehicles were gradually discarded.

The present motor vehicle equipment of the New York Telephone Co. includes forty-five gasolene motor trucks, ranging from one to five tons in capacity, six light electric vehicles, and seventy-five runabouts and touring cars used by superintendents and foremen in covering their respective territories, and therefore coming under the head of automobiles used for business purposes.

A single order for gasolene trucks given a little over a year ago amounted to $100,000.

The majority of the trucks are kept in public garages in the territories in which they are used. A repair shop is maintained at the Brooklyn garage, in charge of an expert mechanic, and all the company's motor vehicles in need of repair are sent there.

The New York Telephone Co. uses its motor trucks for the transportation of materials, tools and workmen, as movable power plants to draw cables through conduits and for stretching cables and wires on poles, to erect poles, and to collect coins from the pay stations. It is the light vehicles used in the country districts which are showing the biggest saving. The principal work done there consists of small jobs, and a day's schedule usually is made up of several hour or half-hour jobs, with jumps of from one to seven miles between. The light trucks carrying materials, tools, and a gang of men make these jumps at a speed close to twenty miles an hour, and will carry a pole or two in tow at a speed but little less than

Digitized by Google

half of this. Four miles an hour was the limit of the horse-drawn vehicles formerly used for this purpose.

By reducing to a minimum the idle time of these gangs of workmen the motor trucks increase from three to fourfold the work they can accomplish in a day. The speed of the motor trucks is also an important factor in the emergency jobs which are constantly arising and where quick repairs are imperative.

Light motor trucks are also used in the cities to deliver equipment and for collecting coins from the pay stations.

Twenty of the gasolene trucks, with capacities ranging from three to five tons, are equipped with power winches driven by the

THREE-TON TRUCK FOR HEAVY HAULING—MOTOR-DRIVEN POWER WINCH IS SEEN AT BACK OF SEAT.

motors which propel these vehicles. These are used principally as movable power plants to draw cables through conduits in the cities and to stretch cables and wires on poles in the suburban and country districts. They are also used to transport the cable reels, tools, and workmen to and from each job. The old way of drawing cables was by means of a capstan worked by nine men, and twenty feet a minute was considered excellent. The motor trucks used for this work average one hundred feet a minute. The company figures that in drawing cable each motor truck with a crew of twelve men does the work of two and a half two-horse teams, each with a crew of twelve men, thus effecting a remarkable saving.

Digitized by Google

Cost of Operating Five-ton Hewitt Gasoline Truck for Three Years by New York Telephone Co.

	Wages.	Garage.	Gasoline.	Oil.	Tyres.	Supplies and repairs.	Monthly cost.	Number working days.	Cost per day.	Monthly mileage.	Average daily mileage.	Cost per mile.	Cost gasoline per mile.	Cost oil per mile.	Cost tyres per mile.
Average per month for first year .	112·57	29·75	38·59	15·76	46·10	30·91	273·67	26	10·86	503¾	19·43	·5636	·0767	·0309	·0915
Average per month for second year	110·75	30·08	30·70	5·80	43·75	34·26	257·22	23	11·14	436⅔	18·91	·5895	·0749	·0133	·0999
Average per month for third year .	120·11	38·69	31·27	6·43	36·27	68·59	301·36	25	11·97	436½	17·34	·6905	·0716	·0147	·083
Average per month for three years	114·48	32 84	34·19	9·33	42·01	44·58	277·42	24⅘	11·32	459	18·56	·6145	·0744	·0196	·0915

Three cost items: interest on investment, insurance, and depreciation, which come under the head of fixed charges, are not included in the above table. The New York Telephone Company figures the interest at 6 per cent., insurance at 8 per cent., and depreciation at 12½ per cent. With these fixed charges figured in, the average daily cost for the three years (890 working days) is $14·15.

Digitized by Google

The company is now rigging one of its large trucks with a demountable derrick for use in erecting poles. A horse-drawn truck similarly rigged has been in use for some time, and with it six men can do the work done by eighteen men in the old way. The horses are unhitched and furnish the necessary power to lift the poles into the holes. The time lost in this will be saved by the motor truck, which can also be used on single pole jobs with long jumps between, because of its speed. Where overhead trolley wires interfere, and where poles are erected across country, these derricks cannot be used.—*Extracted from an article by John R. Eustis in 'Telephony.'*

CORK GAME-GUARDS.

By F. W. Best.

Cork game-guards are now stocked by the Controller of Stores, and it is probable that the use of the cork game-guard will become general.

It is believed that cork game-guards were first used in the Oldham section, and that their use was suggested by Mr. C. J. Sirett, who was in charge of the section a few years ago.

The guards are used upon exposed lines crossing high moorland, and their chief advantage lies in their visibility during breezy weather.

The aluminium guard during a strong steady breeze assumes a horizontal position and becomes practically invisible to the flying game.

Another point was the fact that the life of the aluminium guard on exposed moorland lines outside Oldham is short, and in no case extending beyond two years.

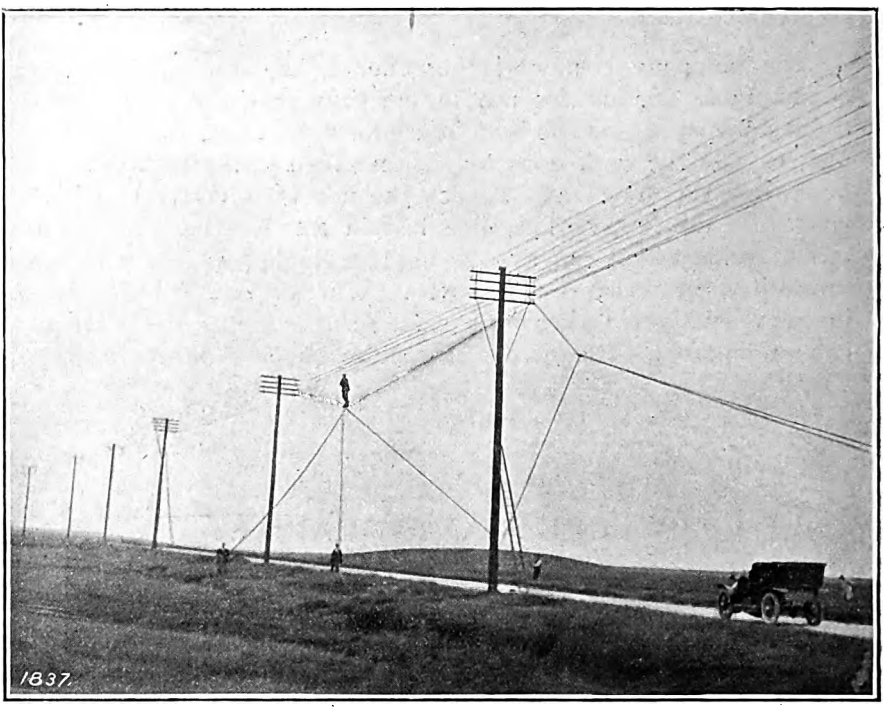
The fibre tube swells under the influence of moisture, the barrel opens, and the guard finally drops to the ground. Apart from this the aluminium guard corrodes rapidly in the moist and chemical laden atmosphere of the neighbourhood, the corrosive consisting of basic carbonate, sulphate, and chloride of ammonia.

On the other hand the cork guard exposed to the same conditions is affected but slightly and lasts considerably longer.

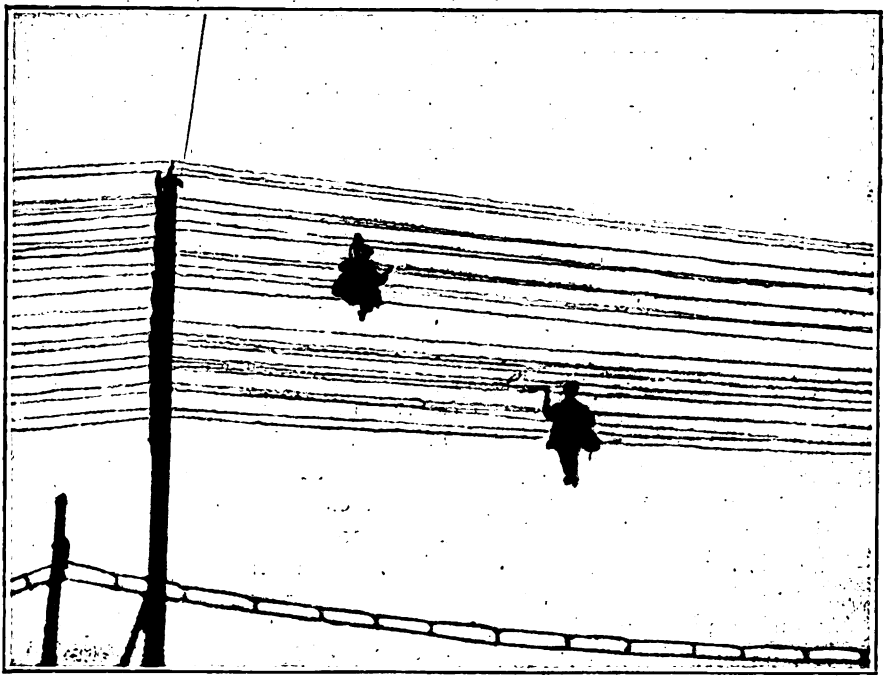
Various sizes and shapes of corks have been tried experimentally, and the cork which has been found to be most satisfactory is one measuring 3 in. by 1⅛ in. with the shoulders slightly rounded.

Each cork is half split lengthwise by means of a keen saw and drilled through the centre longitudinally, the size of the hole being

Digitized by Google



1.—Fixing Cork Game-guards at Buckstones, Oldham–Huddersfield Line.



2.—Using Bo'sun's Chair to remove Cotton Fluff from Wires. Littleborough, Lancs.

Digitized by Google

less than the gauge of the wire upon which it is to be fitted in order that the wire may be well gripped by the cork.

Thus for 300 lb. wire a 150 lb. gauge hole is drilled, and for a 200 lb. wire a hole equivalent to 100 lb. gauge is made, and so on.

The cork is bound at each end with 50 lb. copper wire.

The corks cost 8*s.* 4*d.* per hundred locally.

To avoid the necessity and expense of dropping the conductors for the attachment of the corks, a "bo'sun's chair" suspended by means of a pulley running on 4/8 strand wire or rope terminated at each pole in the space is used. The chair is shifted along the suspender by means of a guy line passing round one of the poles and manipulated by the man using the "chair."

By means of the "chair" accumulations of cotton fluff on wires passing close to the "blowing" shafts of cotton mills may be removed without the necessity of dropping the wires, and the second illustration shows a couple of chairs being used for this purpose.

Digitized by Google

332

THE NEW C.B. SWITCHBOARD TYPE 12, AND THE GENERAL APPLICATION OF ITS PRINCIPLES.

By J. HEDLEY,
Engineer-in-Chief's Office.

BEFORE this article appears in print telephone engineers generally will be familiar with the facilities afforded on the C.B. No. 12 board, but it will probably be of interest if the reasons for abandoning the C.B. No. 9 type in favour of the No. 12 type and the details of the development of the latter are briefly stated.

Shortly after the introduction of C.B. working in this country, it was apparent that a cheaper form of C.B. switchboard for small exchanges was desirable, and in 1905 the C.B. No. 9 type was introduced. The physical capacity of this board is limited to 800 lines, and it was adopted by the Post Office as standard for all exchanges with a prospective ultimate development not exceeding that number. This practice was also followed by the Ex-National Telephone Company, and exchanges of this type have been installed by the two administrations as follows:

By the Post Office.—Sutton (now replaced by a C.B. No. 10 board), Harrow, Barnet, Kirkintilloch, Barry (Cardiff).

By the National Telephone Company.—Grimsby, Tottenham, East Ham, Enfield, Kemptown (Brighton), Londonderry, Maidstone, Scarborough, Shipley.

SUPERSESSION OF NO. 9 BOARD.—Although the conditions of service afforded on the C.B. No. 9 switchboard were generally admitted to be superior to other types of small switchboards, magneto and C.B.S., it was very soon apparent that the operating facilities left much to be desired and compared very unfavourably with those available on the No. 1 type, and the desirability of developing an

Digitized by Google

alternative cheap form of C.B. switchboard, free from the operating defects inherent in the C.B. No. 9 type, was fully recognised by the Department's engineers.

The disabilities of the No. 9 board from a traffic point of view are enumerated on the annexed schedule.

Comparison of the Conditions of Service and Operating Facilities afforded on Nos. 1, 9, 10 and 12 C.B. Switchboards.

Circuit.	Conditions of service and operating facilities.	
	Type 9.	Types 1, 10, and 12.
Line circuit	(*a*) Eyeball indicators for calling signals.	(*a*) Lamps for calling signals.
	(*b*) Calling indicators placed at the top of the sections involving strain on the operators in looking upwards.	(*b*) Calling lamps approximately in direct line with operators' normal vision.
	(*c*) All calls answered in the multiple (there are no answering jacks as usually understood); operators have to pick out in the multiple the jack corresponding to the number displayed on the calling indicator.	(*c*) Answering jacks fitted immediately above the calling lamps. No mental effort involved in answering a call; service therefore quicker.
	(*d*) Special arrangements necessary to apply Opal Code. The markings must be made on the calling indicator, the number of which is not displayed during a connection. This involves risk of error in applying the facilities to be afforded.	(*d*) Standard Opal Code provided on the lamp caps. Facilities to be afforded available at all times as a guide to the operators.
	(*e*) I.D.F. not provided, therefore rearrangement of operators' loads not practicable.	(*e*) I.D.F. fitted. Standard cross connection facilities thus available.
	(*f*) 800 lines is the maximum equipment which can be accommodated on the sections.	(*f*) C.B. No. 1 sections usually designed for 5000 to 10,000 lines. Nos. 10 and 12 sections can each accommodate 2000 lines.
Cord circuit	(*a*) Eyeball supervisory signals fitted above the multiple, below the calling indicators, therefore not easily associated with their relative plugs. Operator has to note the number of the clearing indicators, and disconnect the plugs concerned. Time consequently lost in tracing out the "clears."	(*a*) Lamp supervisory signals directly associated with the corresponding plugs. Clearing therefore facilitated.
	(*b*) "Negative" clearing signals obtain, *i. e.* eyeball indicators displayed during conversation. Operators more liable to disregard a disappearing than a "positive" clearing signal.	(*b*) Supervisory lamps dark during conversation. Operators cannot ignore "positive" and insistent lamp signals.
Meter circuit	(*a*) System unsuitable for the equipment of subscribers' meters. All calls must be ticketed, therefore operating slower.	(*a*) System designed for meters to be installed.

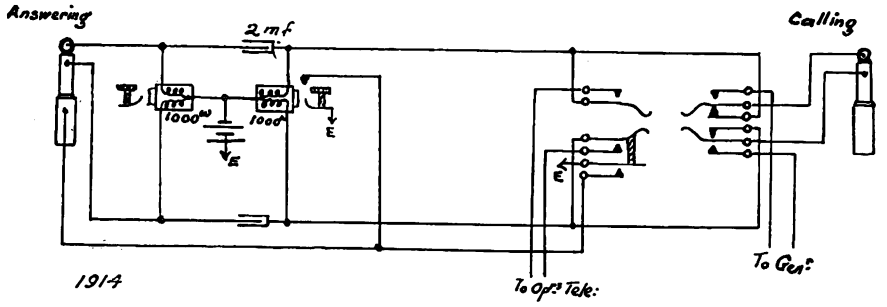
In introducing the No. 12 switchboard, it was considered desirable to instal sections with capacity similar to those used for C.B. No. 10 exchanges, *i. e.* with a multiple field for 2000 subscribers' lines, in

Digitized by Google

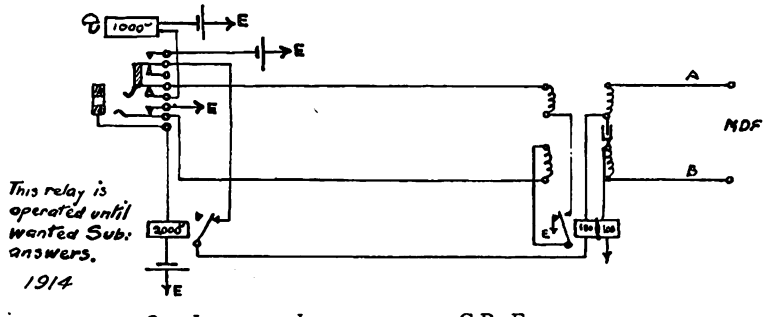
order that the ultimate equipment of the switching plant shall not be governed by the physical limit of the switchboard. This condition is one which is now presenting difficulties in C.B. No. 9 exchanges where growth is needed beyond 800 lines.

1 and 2 show general and detailed views of the face equipment of the No. 12 board, and it will be evident that exchanges of this type are precisely similar in appearance to those where C.B. No. 10 switchboards are installed.

It will also be seen from the schedule that the operating defects



C.B.S. UNIVERSAL CORD CIRCUIT.



3.—INCOMING JUNCTION FROM C.B. EXCHANGE.

of the No. 9 switchboard are entirely absent from the No. 12 type, and that the operating conditions are now precisely similar for the three standard types, Nos. 1, 10 and 12. The entire arrangements for overcoming the objections indicated have been devised by the Department's engineers, without introducing a more expensive type of equipment, and the evolution of the new circuit arrangements provided and the scope of application of their principles are perhaps worthy of special mention.

ORIGIN OF "THROUGH SIGNALLING" CORD CIRCUIT.—During a visit to the Epsom C.B.S. Exchange in 1910 by the writer, it was noticed that there were fifteen incoming junctions terminating on jacks and lamps, and that special straight-through plugs and cords

Digitized by Google

Digitized by Google

Digitized by Google

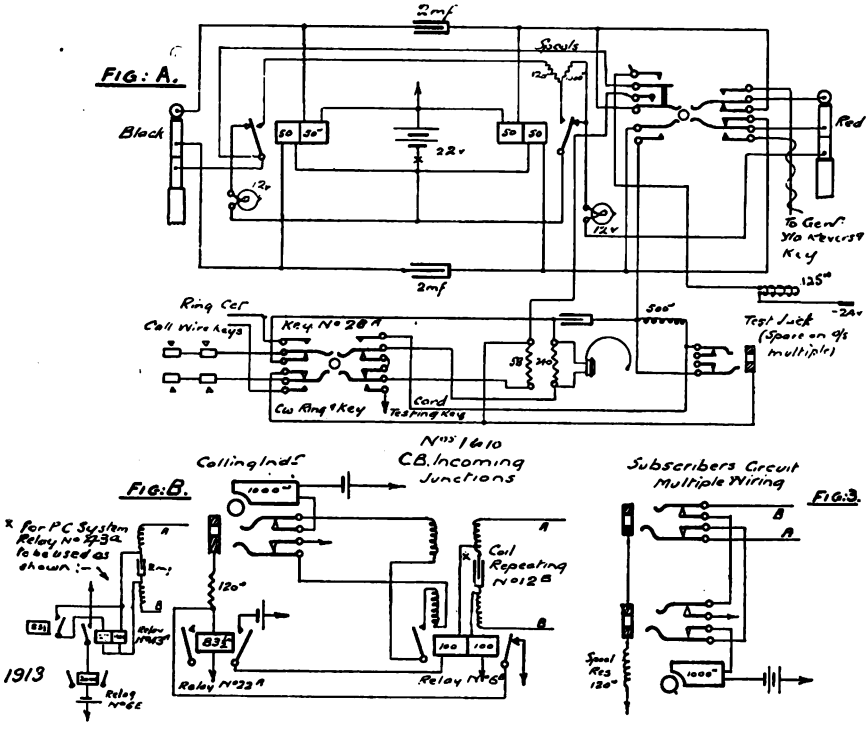
2.—C.B. No. 12—Face Equipment.

Digitized by Google

Digitized by Google

were provided for operating these junctions, but only twelve cords were available.

This condition was, of course, most unsatisfactory, and upon investigation it was found that by rearranging the ordinary subscribers' cord circuit, and modifying the incoming junction equipment associated with the jacks and lamps, it was possible to provide a common cord circuit, suitable for answering both subscribers' circuits and incoming junction circuits, with facilities on the latter for affording "through signalling" from the wanted subscriber, *viâ*



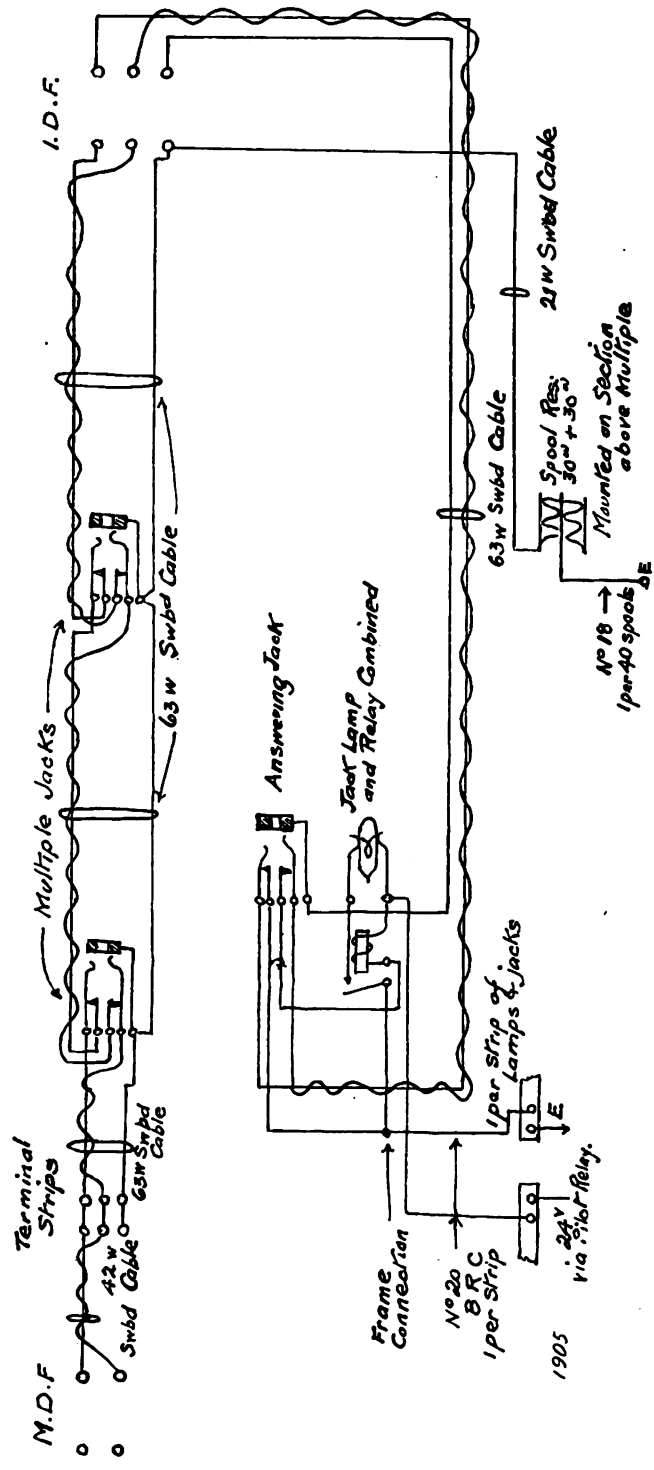
4.—Burgh Heath C.B. Switchboard. Circuit Diagrams.

the ordinary cord circuit, to the originating operator at the distant exchange.

This improvement was achieved by utilising the armature of the subscribers' calling cord supervisory relay to control relays on the incoming junction circuit, and thereby transmitting the signals to the distant exchange through the two sides of the cord circuit (see 3).

It will be of interest to state here that the new junction arrangements for C.B.S. exchanges recently introduced embody this method of signalling on the subscribers' cord and junction circuits.

Digitized by Google



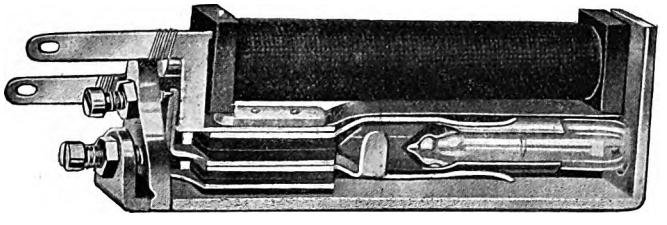
5.—Subscribers' Line Circuit.

Digitized by Google

ADOPTION OF NO. 12 C.B. BOARD AS STANDARD.—This new "through signalling" feature proved so advantageous that it was next introduced under C.B. conditions at Burgh Heath in 1910, where a small departmental C.B. switchboard is installed, and here again the improved facilities afforded were found to be more efficient from an operating point of view. C.B. switchboards of the Burgh Heath type (the pioneer of the adopted No. 12 type) have since been installed by the Department at Shettleston (Glasgow) and Neath.

4 shows typical circuit arrangements employed.

It was evident that the conditions of service afforded on the "Burgh Heath" type of switchboard were much better than those available on the C.B. No. 9 type, and the question of superseding the latter by a standard switchboard based on "Burgh Heath" principles was therefore specially considered. In January, 1911, after a conference between representatives of the Secretary's and Engineer-in-Chief's staff, authority was readily given for the change



6.—COMBINED RELAY AND LAMP SOCKET.

proposed, and it was decided to name the new C.B. switchboard "Type 12."

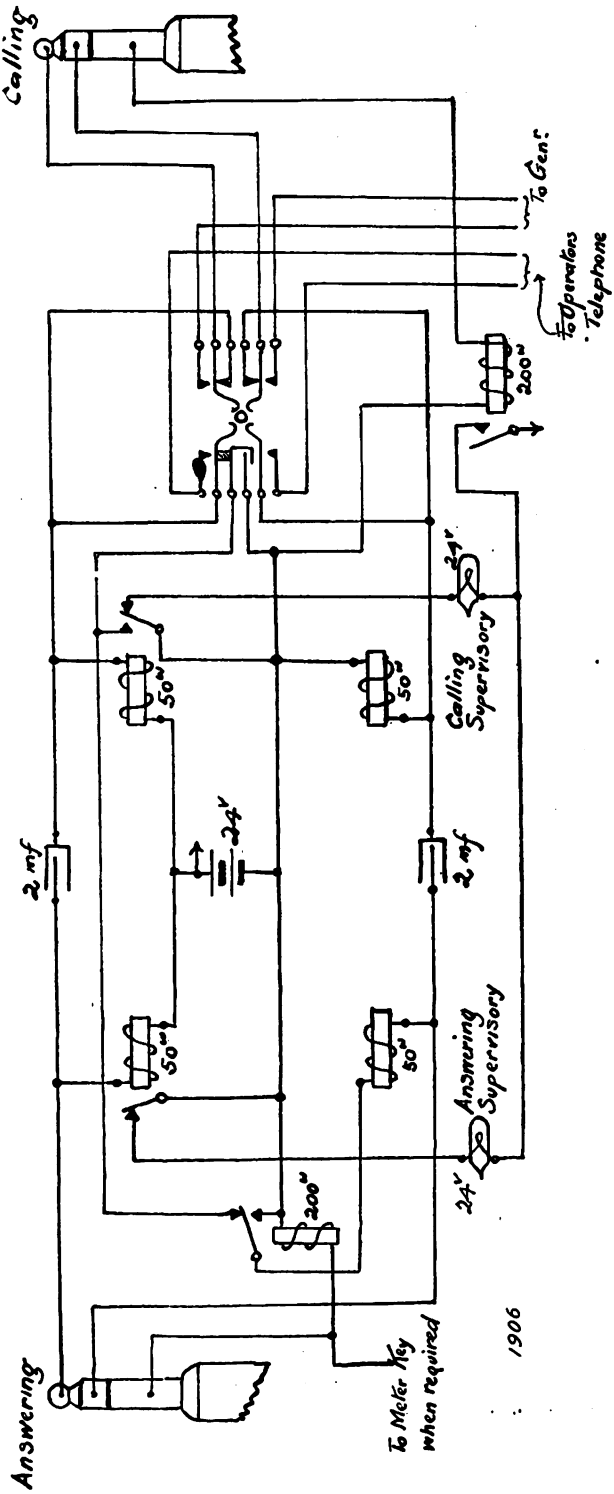
DESCRIPTION OF C.B. NO. 12 CIRCUIT ARRANGEMENTS.—5 shows the subscribers' line circuit, and the new features are as follows:

(1) The line relay and calling lamp are combined on the same mounting strip in a very ingenious manner (see 6). This combination is mounted in strips of twenty below the answering jacks, the label for the latter being fitted above the lamp in a designation strip attached to the mounting in front of the core of the relay.

(2) In consequence of the above, and the fact that cut-off relays are not needed owing to the subscribers' multiple being of the break-jack type, the relay rack accommodation for line and cut-off relays usually necessary in lamp-signalling exchanges is dispensed with.

(3) The cross connection facilities are afforded by running the subscribers' line cables from the M.D.F. *viâ* the multiple jacks in the sections to the I.D.F., the answering jack cables from the latter to the sections being run in the usual manner.

Digitized by Google



7.—Universal Cord Circuit.

Digitized by Google

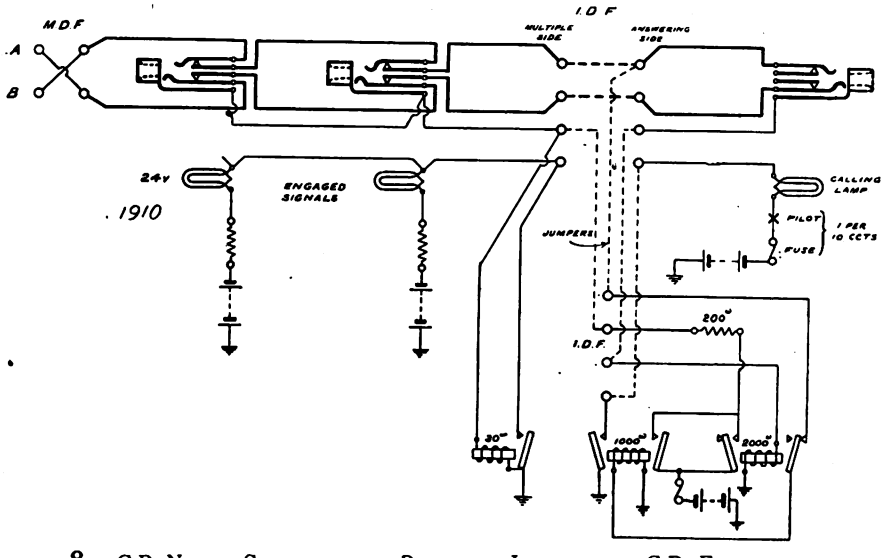
(4) Extensions to the multiple, which are usually difficult with the break-jack type, can be carried out with the minimum disturbance to working circuits, owing to the following arrangements in the design and lay-out :

(*a*) The switchboard is arranged to grow in the direction of the M.D.F.

(*b*) The cables from the M.D.F. are wired to terminal strips before proceeding to the multiple jacks.

(*c*) The length of cable from the terminal strips to the first multiple jack is cut to the exact length necessary for wiring to the next strip of multiple jacks when installed.

7 shows the common cord circuit, and by comparison with the



8.—C.B. No. 12 Switchboard—Both-way Junction to C.B. Exchanges Wiring Diagram.

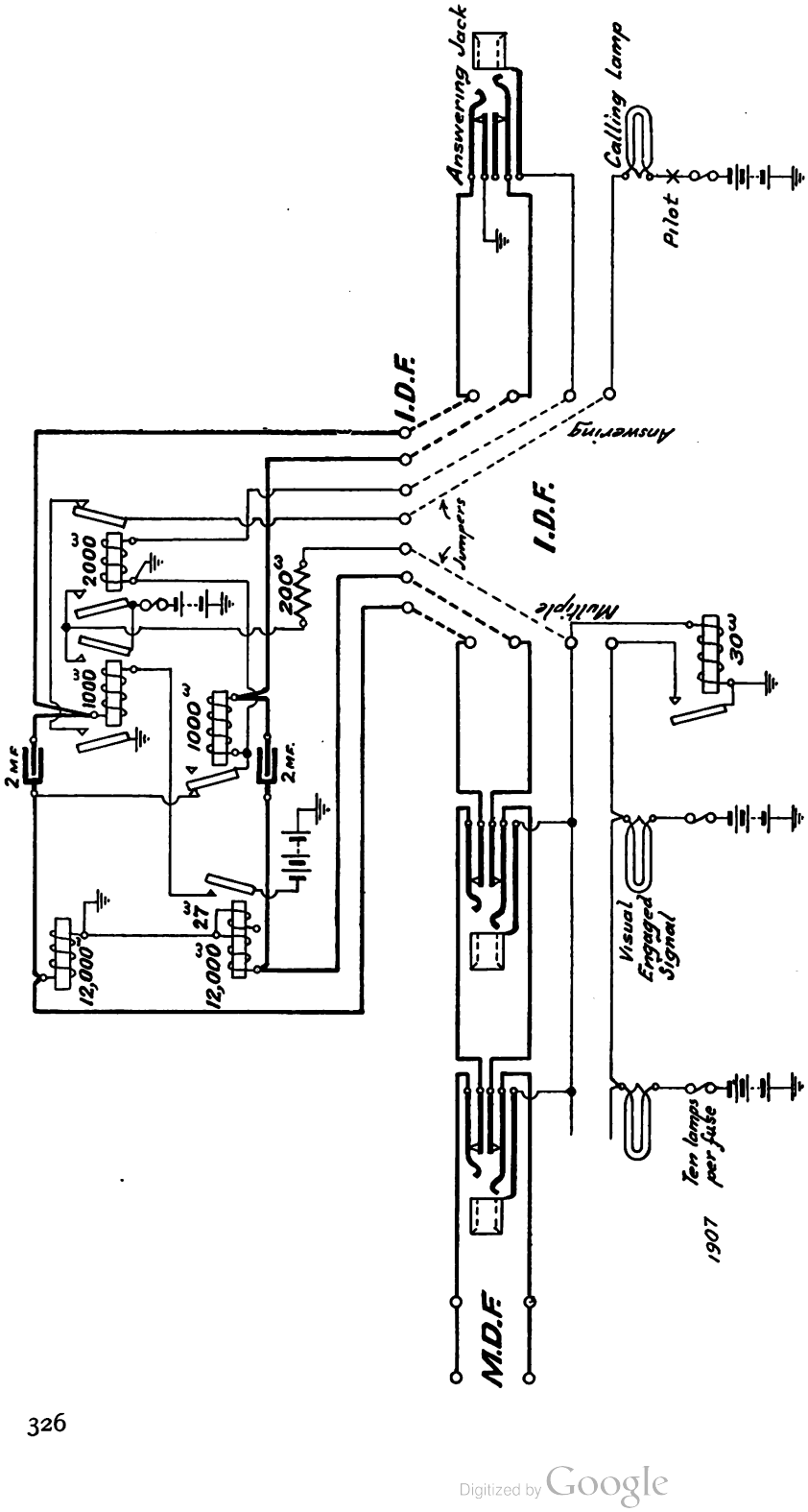
cord circuit shown in 3 and 4, it will be seen that the "through signalling" feature introduced by the writer has been maintained on the new switchboards. The cord circuit has, however, been rearranged by adding a relay in the sleeve circuit. This additional expense is compensated for by the following improvements obtained.

(1) Improvements in transmission over junction circuits between two C.B. exchanges due to the fact that the junction apparatus is cut out of the transmission circuit during speech, *i. e.* junction repeating coil, condenser and relays.

(2) Simplification of incoming junction equipment.

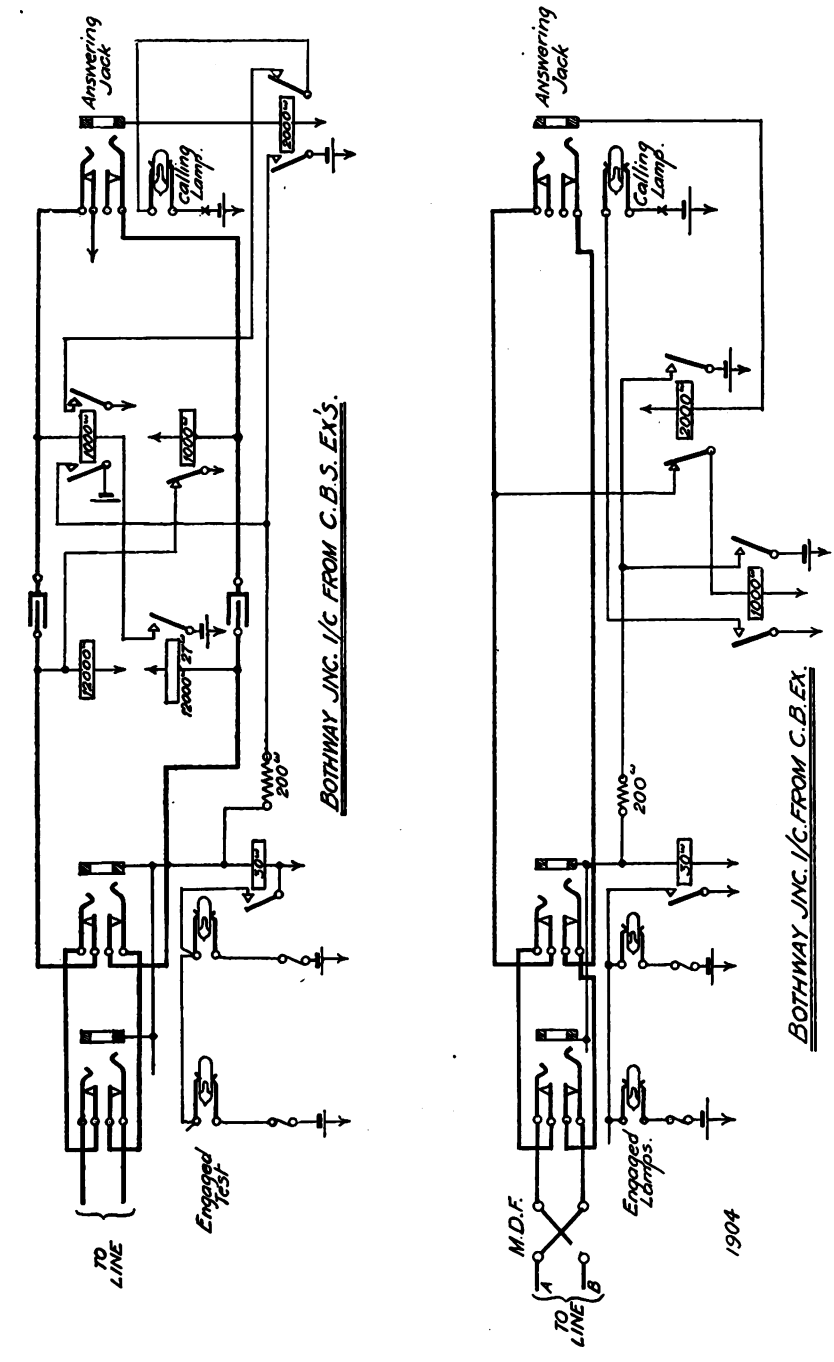
(3) A constant voltage on the socket of the subscribers' jacks when engaged, thus affording a more reliable and unvarying "click" test.

Digitized by Google



9.—C.B. No. 12 Switchboard. Both-way Junction common to C.B.S. and Magneto Exchanges Wiring Diagram.

Digitized by Google



10.—C.B. No. 12 Switchboard. Explanatory Diagrams for Junction Circuits.

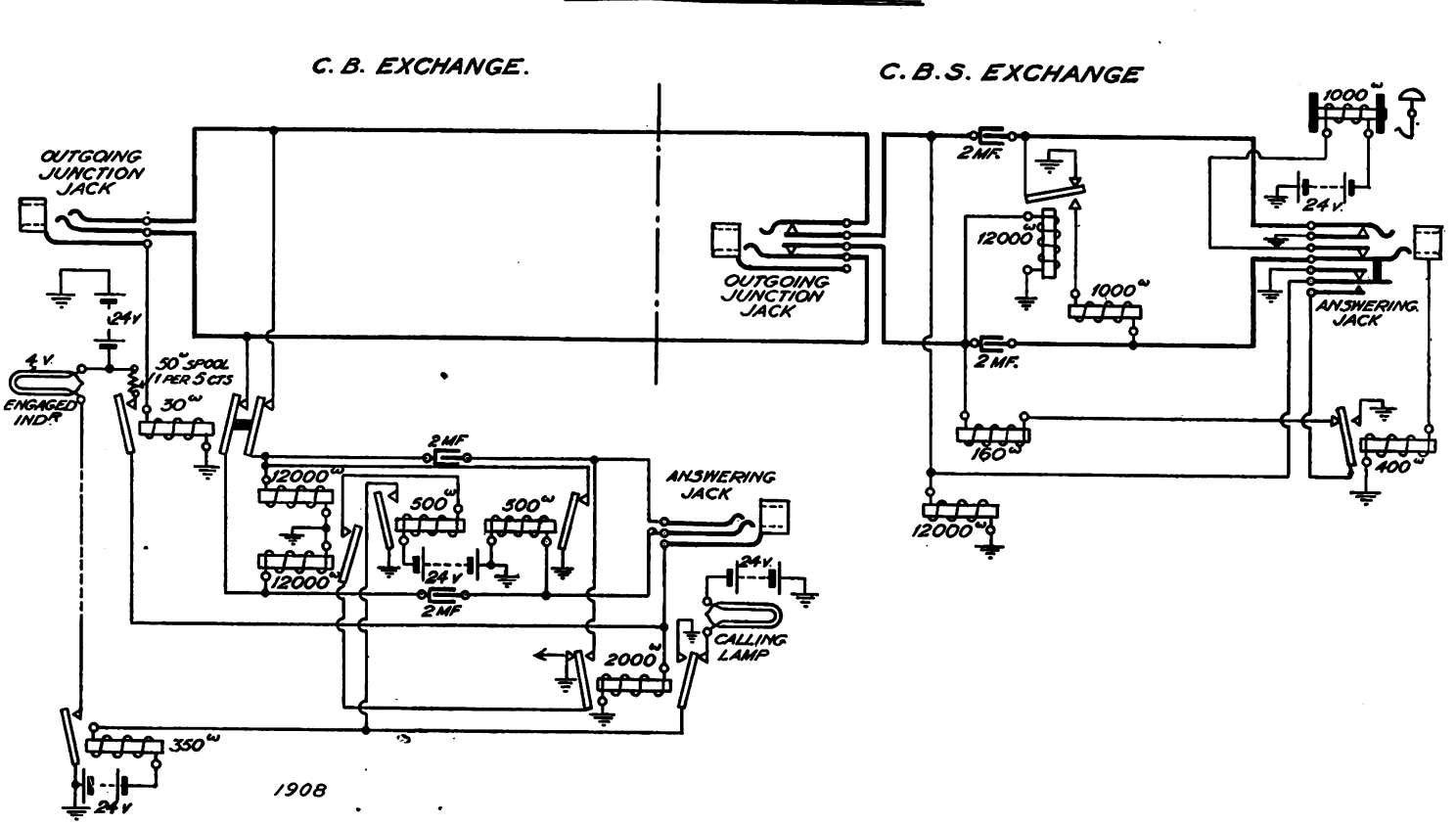
Digitized by Google

8 and **10** (wiring and explanatory diagrams) show a jack-ended both-way junction to a C.B. exchange. The operation of the cord circuit in conjunction with the subscribers' line circuit (**5**) will be self-explanatory, but it will probably be of interest if its operation when dealing with a call incoming from a C.B. exchange is indicated.

When a calling plug is inserted in the outgoing junction jack at the originating C.B. exchange earth is placed on the "A" line *viâ* the supervisory relay, and the battery which passes out to the "B" line *viâ* the retardation coil operates the 1000$^{\omega}$ calling relay at the incoming exchange. This latter operation completes the circuit of the visual engaged signals and calling lamp, and the incoming operator inserts the answering plug of any disengaged cord circuit into the answering jack associated. Under these conditions the current flowing to earth in the sleeve circuit is insufficient to energise the 200$^{\omega}$ cord circuit relay, but reliably operates the 2000$^{\omega}$ relay connected to the socket of the incoming jack, thus disconnecting the calling apparatus from the line and maintaining the circuit of the visual engaged signals.

When the speaking key is thrown to answer, the 22-volt battery is connected to the ring of the incoming operator's answering plug, *viâ* the retardation coil, and, by means of the reversed jumpers on the main frame, this battery is transferred to the "A" line, in order that the earthed supervisory relay at the originating exchange may be energised, a condition which darkens the originating operator's calling supervisory lamp, and notifies to her that the call has been answered. The incoming operator receives the particulars of the call, tests the line wanted in the usual manner, and, assuming that the wanted subscriber is disengaged, the calling plug is inserted and the ringing key operated intermittently. Whilst the operator is obtaining the attention of the subscriber the retardation coil on the ring side of the answering cord is disconnected, consequently the originating operator's supervisory relay is de-energised, and the calling supervisory lamp again glows. The insertion of the incoming operator's calling plug completes the circuit of the 200$^{\omega}$ sleeve relay *viâ* the bush of the wanted subscriber's jack and 30$^{\omega}$ spool to earth; the operation of this relay causes the incoming operator's calling supervisory lamp to glow. When the wanted subscriber answers, the incoming operator's calling supervisory relay is energised, thus disconnecting the corresponding supervisory lamp, and also placing battery on the retardation coil on the ring of the answering plug. This latter operation again provides battery on the "A" line necessary for the supervisory relay at the distant exchange to be energised, thus transmitting the actions of the wanted subscriber to the originating operator, in the standard manner for C.B. exchanges.

Digitized by Google



II.—Both-way Junction Circuit. Diagram showing Arrangement at a C.B.S. Exchange.

Digitized by Google

It will be evident from the foregoing that during speech the cord circuits between two C.B. exchanges are directly connected together, the necessary supervisory signals being effected without any junction apparatus in circuit, consequently the termination of *direct* C.B. incoming junctions can be made on ordinary subscriber's line equipment (5) by—

(*a*) Disconnecting the earth on the inner of the answering jack.

(*b*) Reversing the tip and ring jumpers on the main frame.

(*c*) Omitting the jumper to the sleeve of the answering jack, in order that the 200ω answering cord circuit sleeve relay will remain inoperative during connection.

Junctions incoming from exchanges other than C.B., *i.e.* C.B.S., magneto and trunk are all wired in a similar manner, and 9 and 10 (wiring and explanatory diagrams) show the circuit arrangements. When a plug is inserted at the originating exchange, balanced battery is placed on the line *viâ* a 1000ω + 1000ω indicator or relay. The 12,000ω calling relay on the "B" line of the incoming junction circuit is energised and the usual calling signal received. The earth on the "A" line at the incoming exchange, under normal conditions, enables the 1000ω + 1000ω relay at the originating exchange to operate. This latter condition obtains until the wanted subscriber answers. The earth on the "A" line, which normally short-circuits the 12,000ω retardation coil, is then disconnected as the 1000ω relay on the "B" line is operated, due to battery being placed on the ring of the incoming operator's answering plug by the operation of the incoming operator's calling supervisory relay, as already explained for 8 and 10.

Outgoing Junctions.—In all cases these circuits are connected to break-jacks in the outgoing junction multiple, without any apparatus associated, except the usual spool resistance 30ω, or relay 30ω for visual engaged signals, on the sleeve circuit. At distant exchanges other than C.B., *i.e.* C.B.S., magneto and trunk, the circuit conditions in all cases are shown typically in 11, which indicates the new arrangements for C.B.S. exchanges. At C.B.S. exchanges this junction circuit will be operated by means of a C.B.S. cord circuit on the lines of that shown in 3. The C.B.S. exchange is automatically signalled over the "B" line to "E," *viâ* the 12,000ω relay, and the supervisory relay at the originating C.B. exchange is operated when the 160ω retardation coil is placed across the line, a condition governed by the operation of the 400ω relay connected to the socket of the jack at the C.B.S. exchange. It will be apparent that the circuit for this latter relay is completed when earth is joined to the contact of the C.B.S. calling cord supervisory relay (3), which operation is controlled by the actions of the wanted subscriber.

Outgoing Junctions with Visual Engaged Signals.—It

Digitized by Google

will be noticed that the foregoing junction circuits provide for both-way working with visual engaged signals associated with the outgoing junction multiple jacks. The provision of visual engaged signals was primarily arranged for in connection with the operation of trunk circuits under junction signalling conditions, for the purpose of notifying to the entire group of operators which circuits were idle. The resultant advantages are as follows:

(*a*) Disengaged circuits can be taken up more quickly by operators, thus enabling delayed calls due to "line engaged" to be completed more promptly. The maximum use of the trunk circuits is also ensured.

(*b*) Time occupied in testing for a disengaged line eliminated, thus improving the service, and enabling the operators to make more connections.

(*c*) With both-way working the risk of premature disconnection of a call on the incoming side as the result of an incorrect test being made by an operator on the outgoing side is eliminated.

Owing to the foregoing advantages, the provision of visual engaged signals is being arranged for in new C.B. exchanges for all direct-ringing and both-way junctions, leaving the jacks without visual engaged signals to be utilised for order-wire working only. In connection with forthcoming extensions of existing exchanges, similar provision will doubtless be considered.

It will be recognised, from the description of the various circuits, that precisely similar operating conditions are available on the three standard types of C.B. switchboards, Nos. 1, 10, and 12, so far as the subscribers' line circuit, operators' cord circuit, etc., are concerned. A meter circuit is not usually provided for small C.B. No. 12 exchanges, but the circuit arrangements are designed so that when the provision of subscribers' meters is justified they can be added. Similarly if order-wire working for incoming junctions is desirable the installation of a standard "B" position can be arranged for, to supersede the jack-ended method of working incoming junctions.

FLEXIBILITY OF C.B. NO. 12 EXCHANGE EQUIPMENT.—Attention is drawn to the arrangement of the apparatus and cabling of the various junction circuits, which has been designed so that by varying the cross-connections on the I.D.F. any type of junction circuit may be provided, on any answering jack, on any position, viz.:

(1) Outgoing junctions with or without visual engaged signals.

(2) Incoming ringing junctions from C.B., C.B.S., magneto, or trunk exchanges.

(3) Both-way junctions from C.B., C.B.S., magneto, or trunk exchanges, with or without engaged signals, associated with the outgoing junction multiple jacks.

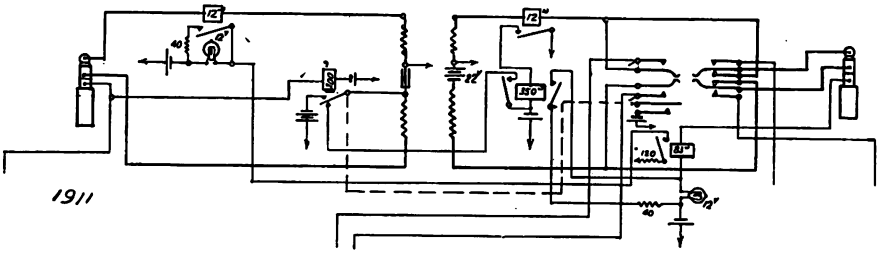
Digitized by Google

The flexibility of the C.B. No. 12 exchange equipment not only permits the maximum use to be made of the junction apparatus but also reduces the idle plant to a minimum, and obviates the necessity for altering the permanent wiring of the exchange equipment for the termination of the various types of incoming junctions.

GENERAL APPLICATION OF C.B. NO. 12 CONDITIONS.—These latter conditions offer such great advantages over previous circuit arrangements that similar circuit conditions and methods of wiring have been introduced in C.B. exchanges of the Nos. 1 and 10 type in connection with the operation of trunks as junctions.

12 shows a typical universal cord circuit based on the lines of the No. 12 board for existing exchanges with "A" line supervisory relays. It will be seen that the "through signalling" feature is again in evidence. The junction circuits are shown in 13, and are similar in operation to those on the C.B. No. 12 board.

JACK-ENDED INCOMING JUNCTIONS.—Prior to the inception of



12.—CORD CIRCUIT AT A NO. 1 C.B. EXCHANGE MODIFIED IN ACCORDANCE WITH THE PRINCIPLES OF A NO. 12 CORD CIRCUIT.

the No. 12 cord circuit with its through signalling facilities, the termination of incoming junctions on jacks in "C.B." exchanges was generally considered to be unsatisfactory from an operating point of view, as the conditions of working were attended by the following disadvantages:

(1) *Calling distant exchange.*
  (*a*) By generator.
  (*b*) Automatically by insertion of plug.
(2) *Clearing from distant exchange.*
  By disconnection of circuit at distant exchange.
(3) No indication when wanted subscriber answered.
(4) False calls received under condition (1) *b*, if distant exchange clears the line first.

The operating objections usually attributable to jack-ended junctions do not apply when No. 12 cord circuits are in use. On the contrary, it is an economical arrangement for small groups of incoming ringing and both-way junctions to terminate as subscribers'

Digitized by Google

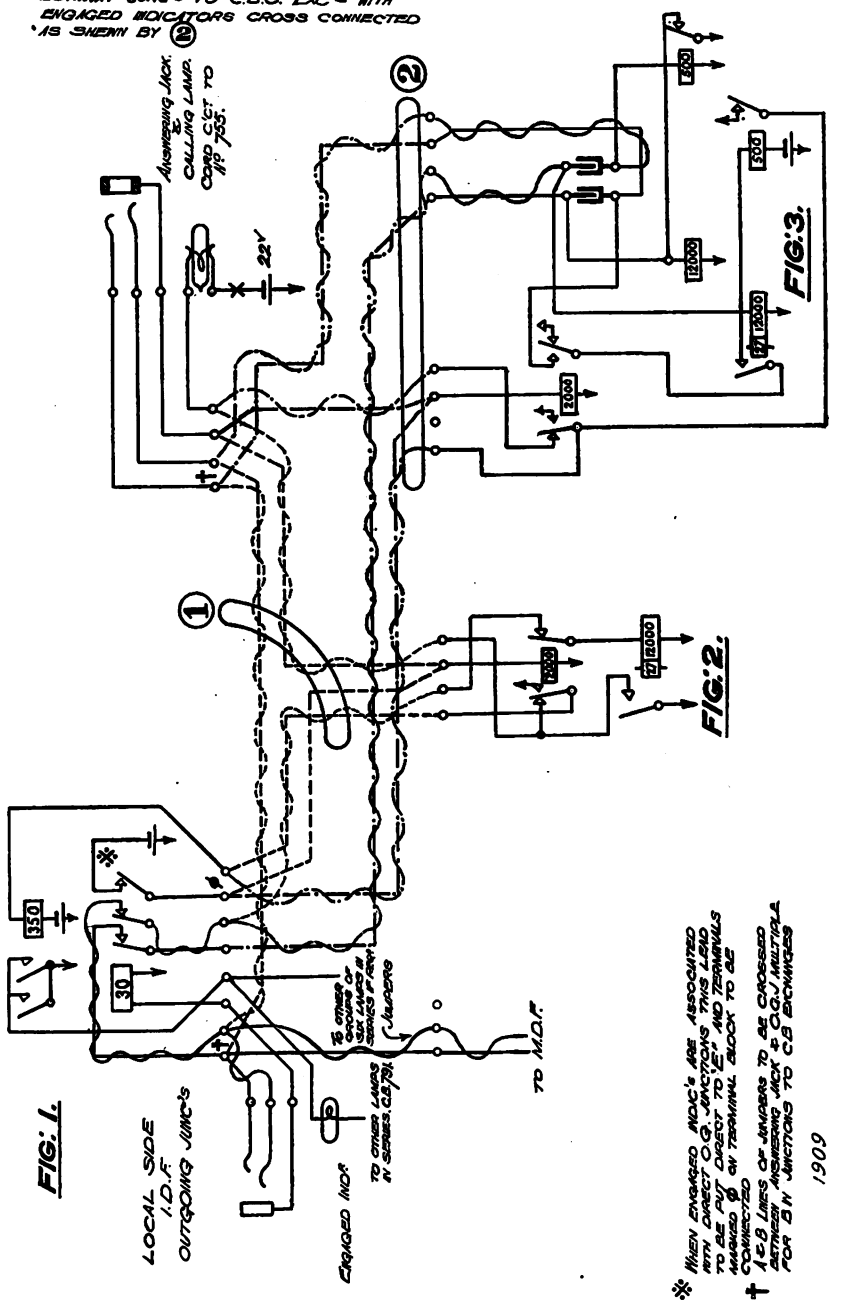


FIG:1. SPECIAL APPARATUS FOR OUTGOING RINGING JUNC'S, WITH ENGAGED IND^RS AND BOTHWAY JUNC'S TO C.B & C.B.S EXC'S.
FIG:2. ADDITIONAL APPARATUS TO FIG:1 FOR BOTHWAY JUNC'S TO C.B EXC'S WITH ENGAGED INDICATORS CROSS CONNECTED AS SHEWN BY (1)
FIG:3. ADDITIONAL APPARATUS TO FIG:1 FOR BOTHWAY JUNC'S TO C.B.S. EXC'S WITH ENGAGED INDICATORS CROSS CONNECTED AS SHEWN BY (2)
ANSWERING JACK. 2 CALLING LAMP. CORD CKT TO 1/P 755.
22V
FIG:3.
FIG:2.
FIG:1.
LOCAL SIDE I.D.F. OUTGOING JUNC'S
ENGAGED IND^S
TO OTHER LINES IN SERIES. C.B.7/31.
TO OTHER GROUPS OF SIX LINES IN SERIES FROM J.BLOCKS
TO M.D.F.
550
30
12000
2000
1909

※ WHEN ENGAGED IND^S ARE ASSOCIATED WITH DIRECT C.O. JUNCTIONS THIS LEAD TO BE TAKEN TO CIRCUIT TO "12" AND TERMINALS MARKED 6 ON TERMINAL BLOCK TO BE CONNECTED

† 1 C.B LINES OR ANSWERS TO BE CROSSED BETWEEN ANSWERING JACK & C.O.J MULTIPLA FOR B'W JUNCTIONS TO C.B EXCHANGES

I3.—WIRING DIAGRAM OF "JACK-ENDED" JUNCTION CIRCUITS AT A C.B. No. 1 EXCHANGE.

Digitized by Google

circuits on jacks, as the cost involved for installing and operating special incoming junction positions is deferred until order-wire working can be justified.

The jack-ended method of working small groups of junctions will be a prominent feature in connection with the Leeds new trunk exchange. As is probably well known, trunk exchanges in future will consist of three types of boards, viz.:

Long distance, for the accommodation of circuits to other zone centres.

"Tandem junction," for the accommodation of large groups of circuits, controlled by order wires.

"Toll junction," for the accommodation of small groups of circuits, to be worked as "ringers" or auto-signalling circuits.

The latter board will be entirely equipped with jack-ended junctions, and will be fitted with cord circuits and junction circuits of the C.B. No. 12 type, thus affording "through signalling" *viâ* the toll board cord circuit from the district exchange subscriber to the originating operator.

At C.B. exchanges where "cypher" incoming ringing junctions are provided for lending purposes only, *e.g.* Hop, Central, North, etc., it will be apparent that some advantage would be gained by terminating these lines on jacks and lamps on special "A" positions equipped with No. 12 cord circuits, as the use of the outgoing order wires and groups of junctions associated therewith would be available, instead of the special ringing junctions in the lending multiple on the "B" board, thus ensuring a quicker service.

In general it is questionable whether it would not be more economical to terminate all incoming junctions, other than those controlled by order wires, on jacks and lamps, in order that—

(*a*) The more expensive equipment on the "B" board may be utilised solely for rapid order-wire working.

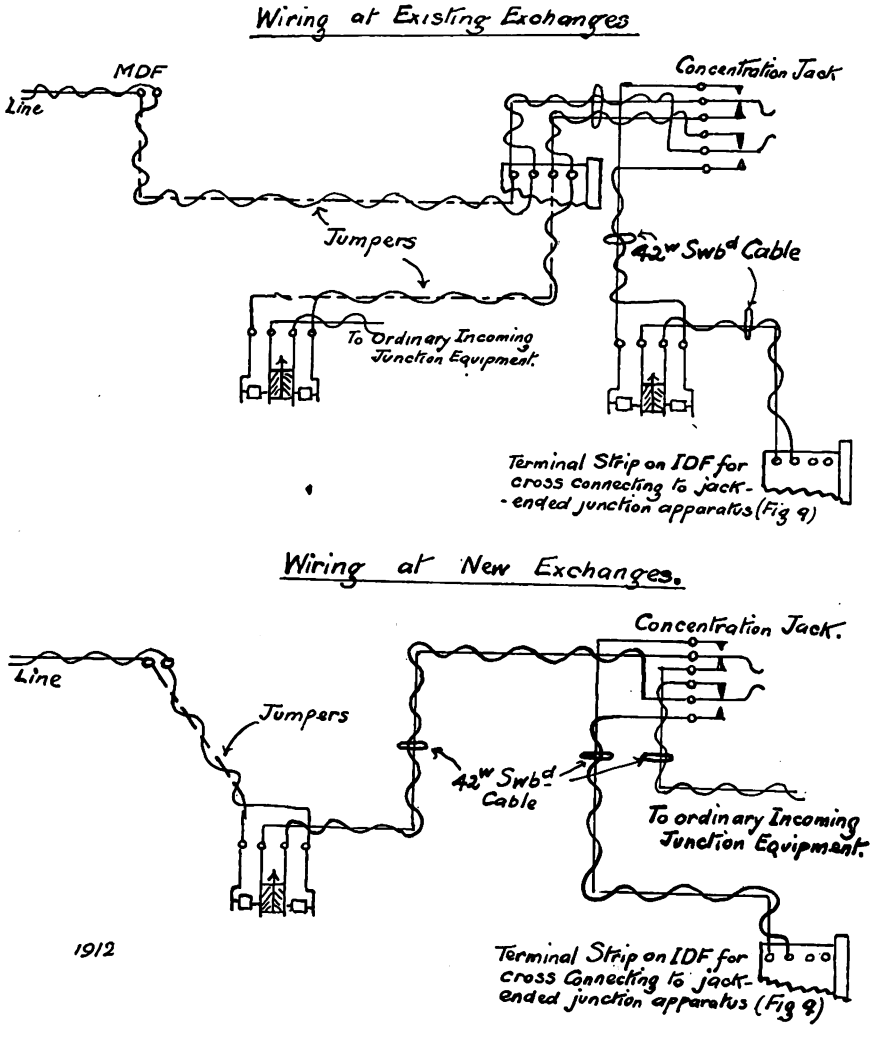
(*b*) Full advantage may be taken of the facilities for concentration during slack periods.

(*c*) Team working can now be introduced for incoming traffic.

With regard to (*a*) it rarely occurs that a ringing junction position carries more unit calls per busy hour than an ordinary A position. The general introduction of jack-ended incoming junctions working from special "A" positions would therefore not reduce the output from an operating point of view; in fact it is probable that under such conditions an operator would be able to deal with more junctions than under the present system, as the operator's load on ringing positions is usually governed by the number of junctions which the position accommodates. The greatest advantage will result from (*c*), as conditions for team working are entirely absent under the plug-ended method of working ringing junctions.

Digitized by Google

CONCENTRATION OF INCOMING JUNCTIONS.—The jack-ended method of working incoming junctions offers ample advantages for concentration during slack periods, as the operator dealing with the jack-ended incoming junction traffic is able to answer originating



14.—CONCENTRATION OF INCOMING JUNCTIONS ON "A" POSITIONS ON JACKS AND LAMPS.

calls from subscribers on the positions within her reach by means of the common cord circuit.

It should perhaps be mentioned that it would also be possible to arrange for the number of order-wire junctions incoming from each exchange necessary to carry the traffic during slack periods to be

Digitized by Google

specially dealt with, and provided with auxiliary apparatus suitable for terminating the lines chosen on jacks and lamps as shown in 14, thus enabling the incoming junctions to be operated side by side with subscribers, and rendering possible the closing of the entire "B" board without in any way interfering with the service afforded under normal conditions during slack periods. The maximum concentration would thus be available.

The question of concentrating incoming junctions has, of course, been previously considered, but the methods suggested necessitated the use of incoming junction plugs not in use, or thrown spare during the slack period. This arrangement presented engineering problems difficult of solution. The facilities now available for providing auxiliary equipment suitable for terminating the incoming junctions on jacks and lamps on "A" positions will probably result in the question being reconsidered, as the following flexible arrangements will be possible: "A" positions fitted with jack-ended junction equipment, utilised for dealing with originated traffic *solely* during the day, can be arranged to give a full operator's load during slack periods by transferring incoming junctions from the "B" positions, thus enabling the latter to be closed, and making the maximum use of the equipment and staff.

This article should not be closed without reference to a passing condition which has been catered for in C.B. No. 12 equipments. 7 shows the supervisory relay on the tip side, and battery withheld from the retardation coil on the ring side of the answering cord circuit. The majority of the C.B. exchanges in the provinces are fitted with supervisory relays on the ring side of the cord circuit, and in order that the simple arrangement of incoming junctions may be in evidence, a C.B. No. 12 cord circuit with supervisory relay on the ring side and earth withheld from the retardation coil on the tip side has been arranged for, but up to the present this latter type has been installed at Sale (Manchester) only, and is known as type 12 B.

In view of the foregoing it was originally intended to provide "B" line supervisory relays on No. 12 equipments, but in connection with the introduction of junction signalling conditions over long trunk circuits it is found to be advantageous for the junction calling relays and cord circuit supervisory relays to be normally at zero potential, in order to ensure that their operation will be entirely under the control of the battery from the distant exchange. With "B" line supervisory relay cord circuits the battery is normally connected to the line, and in wet weather, when insulation losses are in evidence, it is difficult to adjust relays to release reliably after the circuit is disconnected at the distant exchange, as the battery "behind" the relay keeps it energised *viâ* the line losses.

With "A" line supervisory relay cord circuits the battery is fed

Digitized by Google

viâ the retardation coil, and the earthed supervisory relay can consequently be given a finer adjustment, as releasing troubles due to line losses are of course not met with.

In launching the No. 12 board it was this condition which made it necessary to adopt as standard, cord circuits with "A" line supervisory relays. The transfer of existing exchanges affected to this method of working will be dealt with as occasion arises.

With few exceptions C.B. No. 1 exchanges in the provinces are fitted with cord circuits having "B" line supervisory relays, whereas in London the majority of the exchanges are provided with "A" line supervisory relays. This latter method was arranged for in order to enable "B" line power feeding for subscribers' private branch installations to be provided, a condition which has not been adopted in the provinces, and which is now obsolescent in London.

TELEPHONE TRANSMISSION.

By F. ADDEY, B.Sc.

(*Continued from p.* 231.)

IN order to use the formulæ just obtained we require to know the electrical data of the circuits with which we are dealing. The actual methods of measurement will be described in the next section. We will here confine ourselves to the manner in which the results of the measurements are analysed.

By means of suitable apparatus we can measure the impedance at the sending end of the circuit, first with the distant ends of the loop insulated, and then with the distant ends short-circuited. These results are called the open and closed sending-end impedances. They will be denoted by $\hat{Z}_1^o$ and $\hat{Z}_1^c$ respectively.

We have already obtained the following equation (equation 15):

$$\hat{Z}_1 = \hat{Z}_o \left[\frac{\tanh al + \frac{\hat{Z}_r}{\hat{Z}_o}}{1 + \frac{\hat{Z}_r}{\hat{Z}_o} \tanh al} \right].$$

Dividing above and below by $\hat{Z}_r$ we get—

$$\hat{Z}_1 = \hat{Z}_o \left[\frac{\frac{1}{\hat{Z}_r} \tanh al + \frac{1}{\hat{Z}_o}}{\frac{1}{\hat{Z}_r} + \frac{1}{\hat{Z}_o} \tanh al} \right].$$

Digitized by Google

If the distant end be open $\hat{Z}_r$ is infinity.

We therefore obtain $\hat{Z}_1^o = \hat{Z}_o \left[\frac{o + \frac{1}{\hat{Z}_o}}{o + \frac{1}{\hat{Z}_o} \tanh al} \right]$

$$\hat{Z}_1^o = \hat{Z}_o \frac{1}{\tanh al} = \hat{Z}_o \frac{\cosh al}{\sinh al}$$

If the distant end be closed we have $\hat{Z}_r = o$.

Substituting in equation (15) we obtain

$$\hat{Z}_1^c = \hat{Z}_o \left[\frac{\tanh al + o}{1 + o} \right]$$

$$= \hat{Z}_o \frac{\sinh al}{\cosh al}.$$

Hence— $$\hat{Z}_1^o \times \hat{Z}_1^c = \hat{Z}_o^2$$

or $$\hat{Z}_o = \sqrt{\hat{Z}_1^o \times \hat{Z}_1^c}.$$

Thus $\hat{Z}_o$ is found.

We now want to find α, the complex attenuation constant.

We have—

$$\frac{\sinh al}{\cosh al} = \sqrt{\frac{\hat{Z}_o \frac{\sinh al}{\cosh al}}{\hat{Z}_o \frac{\cosh al}{\sinh al}}} = \sqrt{\frac{\hat{Z}_1^c}{\hat{Z}_1^o}} = h, \text{ say.}$$

Also $\sinh al = \frac{e^{al} - e^{-al}}{2}$,

and $\cosh al = \frac{e^{al} + e^{-al}}{2}$.

Hence $h = \frac{e^{al} - e^{-al}}{e^{al} + e^{-al}}$.

Therefore $1 + h = 1 + \frac{e^{al} - e^{-al}}{e^{al} + e^{-al}} = \frac{2e^{al}}{e^{al} + e^{-al}}$,

and $1 - h = 1 - \frac{e^{al} - e^{-al}}{e^{al} + e^{-al}} = \frac{2e^{-al}}{e^{al} + e^{-al}}$.

Therefore $\frac{1 + h}{1 - h} = \frac{e^{al}}{e^{-al}} = e^{2al}$.

Now $a = \alpha + i\beta$,

Therefore $\frac{1 + h}{1 - h} = e^{2(\alpha + i\beta)l} = e^{2\alpha l} e^{i2\beta l}$.

Thus the vector $\frac{1 + h}{1 - h} = R/\theta$,

where $R = e^{2\alpha l}$ and $\theta = 2\beta l$.

Hence $\alpha = \frac{1}{2l} \log_e R$

Digitized by Google

and $\beta = \frac{\theta}{2l}$.

When α and β are known, the value of a can be found.

Now $a = \sqrt{\hat{I}\hat{Y}}$

and $\hat{Z}_o = \sqrt{\frac{\hat{I}}{\hat{Y}}}$

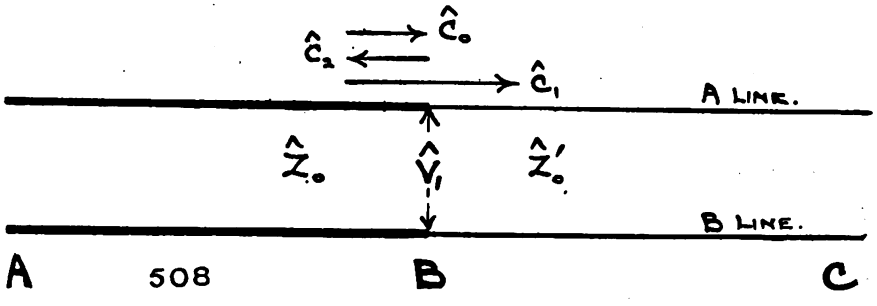
Thus, knowing a and Z_o we can calculate the values of $\hat{I}$ and $\hat{Y}$.

But $\hat{I} = R + ipL$,

and $\hat{Y} = S + ipK$.

Hence, resolving $\hat{I}$ and $\hat{Y}$ into their real and imaginary parts we can obtain the values of R, L, S, and K.

REFLECTION EFFECTS IN TELEPHONE CIRCUITS.—If we have a circuit made up of different types of conductor reflection may



9.—REFLECTION IN TELEPHONE CIRCUIT.

occur at the points of junction. It is necessary to be able to allow for these reflections in our calculations. The general case is somewhat complicated. If, however, the lengths of the portions of the circuit on either side of the point of junction be so long that the characteristic impedance of each portion may be used as the impedance at the sending end, reflection effects from the ends may be neglected, and the problem is much simpler.

Suppose a cable AB (9) of characteristic impedance $\hat{Z}_o$, continued by a cable BC of characteristic impedance $\hat{Z}^1_o$. Let the value of the vector current across the junction of the A lines be $\hat{C}_1$. We may confine our attention to the A lines, remembering that precisely similar effects will be produced in the B lines, except that the signs will be reversed.

We may then look upon $\hat{C}_1$ as being the difference between the vector current $\hat{C}_o$, which would have been the value of the current at the junction if the circuit had been uniform, and a vector current $\hat{C}_2$ which is reflected from the point of junction. The current $\hat{C}_o$ is

Digitized by Google

supposed to split up at the junction into the transmitted portion $\hat{C}_1$ and the reflected portion $\hat{C}_2$.

$$\text{Hence } \hat{C}_1 = \hat{C}^o - \hat{C}_2 \quad . \quad . \quad . \quad . \quad (17)$$

Let $\hat{V}_1$ be the vector voltage across the circuit at the point of junction.

$\hat{V}_1$ may be considered as the resultant of two vector voltages, one driving $\hat{C}_o$ in one direction, and the other driving $\hat{C}_2$ in the opposite direction. Therefore—

$$\hat{V}_1 = \hat{V}^o + \hat{V}_2 \quad . \quad . \quad . \quad . \quad (18)$$

Let $\hat{C}_1 = m\hat{C}_o$. Then $\hat{C}_2 = (1 - m)\,\hat{C}_o$ from (17).

Now $\hat{V}_o = \hat{C}_o\hat{Z}_o$, since $\hat{C}_o$ is the current which would have been sent if the cable AB had been continuous.

Also $\hat{V}_1 = \hat{C}_1\hat{Z}'_o$

and $\hat{V}_2 = \hat{C}_2\hat{Z}_o$.

Therefore, from (18), $\hat{C}_1\hat{Z}'_o = \hat{C}_o\hat{Z}_o + \hat{C}_2\hat{Z}_o$.

Hence, substituting for $\hat{C}_1$ and $\hat{C}_2$, we get—

$$m\hat{C}_o\hat{Z}'_o = \hat{C}_o\hat{Z}_o + (1-m)\hat{C}_o\hat{Z}_o$$

$$m\hat{Z}'_o = \hat{Z}_o + (1-m)\hat{Z}_o$$

Therefore, $m\hat{Z}'_o = 2\hat{Z}_o - m\hat{Z}_o$,

Therefore, $m = \dfrac{2\hat{Z}_o}{\hat{Z}'_o + \hat{Z}_o}$.

This is called the "*co-efficient of transmission.*"

Also $1 - m = 1 - \dfrac{2\hat{Z}_o}{\hat{Z}'_o + \hat{Z}_o} = \dfrac{\hat{Z}'_o - \hat{Z}_o}{\hat{Z}'_o + \hat{Z}_o}$.

This is called the "*co-efficient of reflection.*"

If, instead of the type of circuit being changed, a receiver of impedance $\hat{Z}_r$ be joined to the circuit AB, $\hat{Z}_r$ takes the place of $\hat{Z}'_o$, and we get—

$m = \dfrac{2\hat{Z}_o}{\hat{Z}_r + \hat{Z}_o}$ for the transmission co-efficient,

and $1-m = \dfrac{\hat{Z}_r - \hat{Z}_o}{\hat{Z}_r + \hat{Z}}$ for the reflection co-efficient.

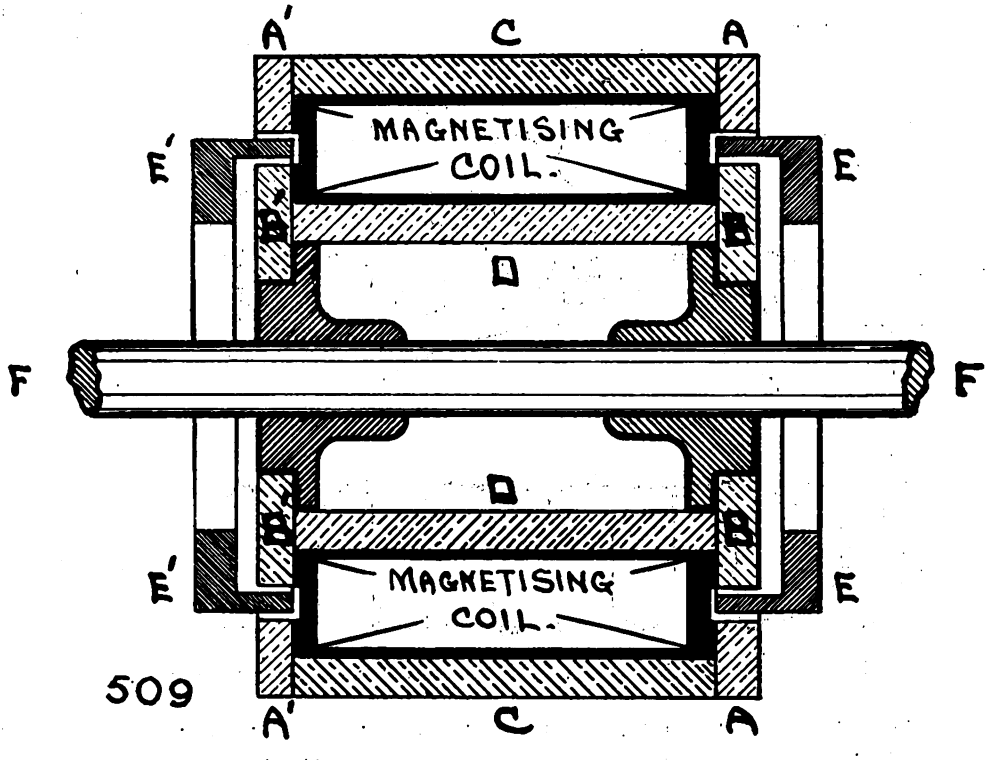
METHODS OF MEASUREMENT.—It will have been realised from the foregoing discussion of the theory of telephone transmission that we are as much concerned with the measurement of the phase angles between the vector quantities with which we have to deal as we are with the actual magnitudes of these quantities. The methods employed for such measurements may be divided into two main classes—those in which the value of the angles can be directly observed, and those in which their value is deduced by calculation

Digitized by Google

from certain other observed results. I propose in this section to describe two methods of each class.

The alternate current generator designed by Dr. A. Franke belongs to the first class. The principle of this machine is shown in 10 and 11 and a photograph of the machine is reproduced in 12.

On the shaft F are mounted by non-magnetic supports two hollow soft iron cylinders C and D. To the ends of these cylinders are fixed soft iron rings A, A', B, B'. As shown in the upper portion



10.—Section of Franke Machine.

of 11 the inner edges of A, A', and the outer edges of B, B' are cut into the same number of teeth. The rings are set so that each tooth in one ring is opposite a tooth in the other ring. A coil is wound in the space between the two cylinders. A current is passed through this coil from slip rings, which causes a magnetic flux to be set up along the cylinders and across the gaps between the ring AB and $A'B'$. The density of the flux is greatest between the summits of the teeth.

Into the gaps between the rings AB and $A'B'$ project the flanges of the slate rings E, E' (10). Notches are cut through the flanges, and in these notches a zig-zag coil is wound, as shown in the lower

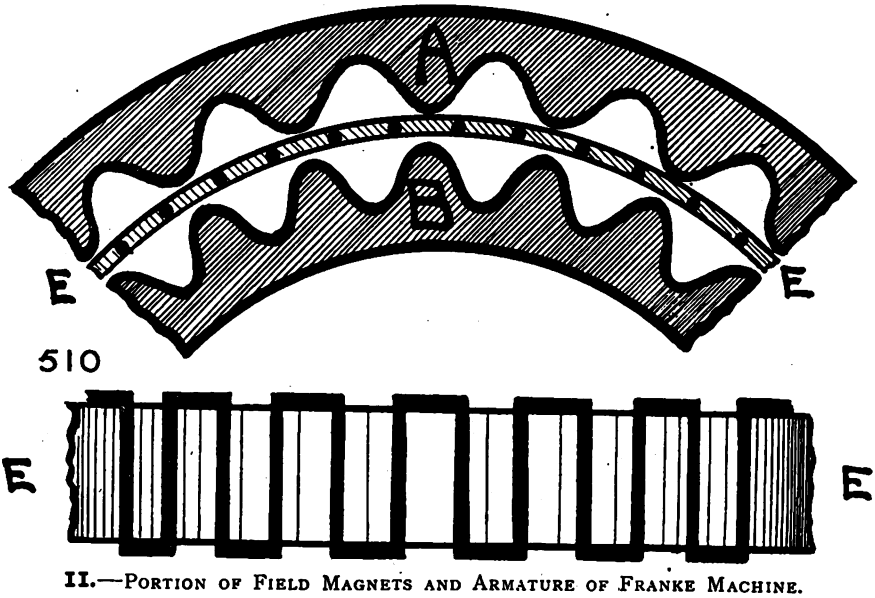
Digitized by Google

portion of 11. There are double the number of notches in the slate rings as there are teeth in the rings A or B.

These slate rings remain stationary, while the iron cylinders revolve.

The actual magnetic field between the rings A and B may be considered as being made up of a uniform field on which is superimposed a non-uniform field due to the teeth. The teeth are so shaped that, as nearly as possible, the non-uniform field varies harmonically as we go round the circumference.

As these two magnetic fields cut across the zig-zag winding they set up in it electromotive forces. The electromotive forces due to



11.—Portion of Field Magnets and Armature of Franke Machine.

the uniform field will be equal, but in opposite directions along the coil, in each successive portion of the zig-zag winding. They will therefore mutually annul one another. The non-uniform field, however, will set up alternating electromotive forces in the windings and these electromotive forces will approximately follow a simple harmonic law.

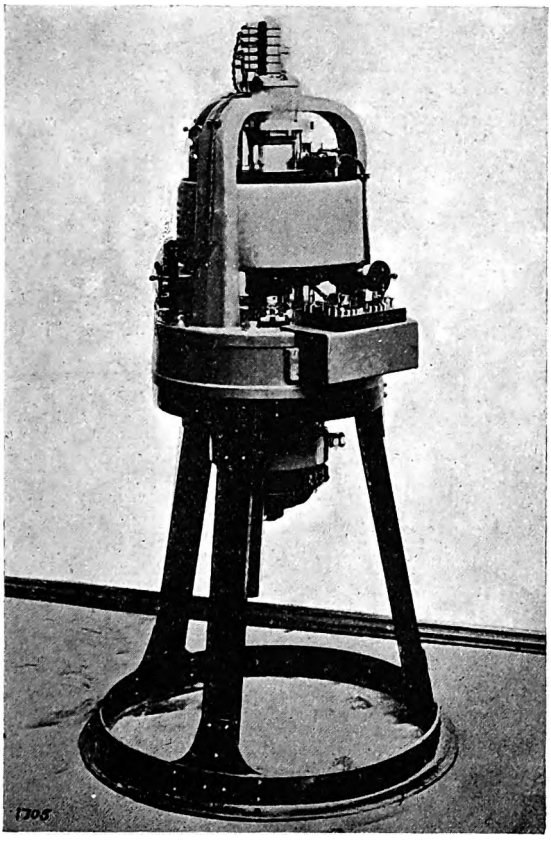
The amount by which the flange of E projects into the gap between the rings AB can be varied by turning a screw. In this manner the magnitude of the electromotive force in E can be made to bear any ratio, less than unity, to the electromotive force in E'.

On the other hand the ring E' can be rotated about its axis by turning a screw. It is evident that shifting the ring E' through an angle equal to that between two teeth will alter the phase of

Digitized by Google

the electromotive force in the winding on E' by a whole period. Any smaller angular displacement of E' will correspond to a proportionately smaller phase alteration. The screw by which the angular motion is obtained is graduated so that the phase displacement produced can be read off directly.

The following example will explain the method of using the Franke machine.



12.—Dr. A. Franke's A.C. Generator.

Suppose we desire to measure the impedance at the sending end of a telephone cable.

The machine is joined up as shown in 13. The ends of the coil E' are joined to the cable through the non-inductive resistance R. The ends of the coil E are joined through a telephone receiver first to the extremities of the cable and afterwards to the terminals of the resistance R.

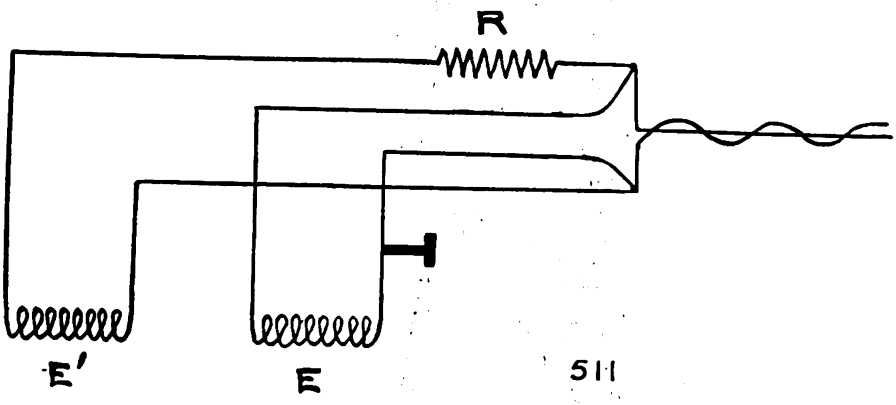
In each case the magnitude of the electromotive force in E and

Digitized by Google

the phase of that in E' are varied until silence is obtained on the telephone. Then in each case we know the magnitude of the electromotive force across the points in question relative to that in E', and also the amount by which these electromotive forces differ in phase from that of the electromotive force in E'. Hence we know the phase relation of the electromotive forces across the resistance R and across the cable terminals, and since R is known, the value of the current passing into the cable can be found. Then knowing $\dot{C}_n$ and $\dot{V}_n$ we have—

$$\frac{\dot{V}_n}{\dot{C}_n} = \dot{Z}_1.$$

The second machine to be described in which phase angles can



13.—Method of using Franke Machine.

be read off directly is the Drysdale Alternate Current Potentiometer.

The principle of this apparatus is shown in 14. It consists of a potentiometer slide wire AB along which alternating currents can be sent from the same generator (designed to give, as nearly as possible, a sine wave) as is used for supplying current to the circuit under observation.

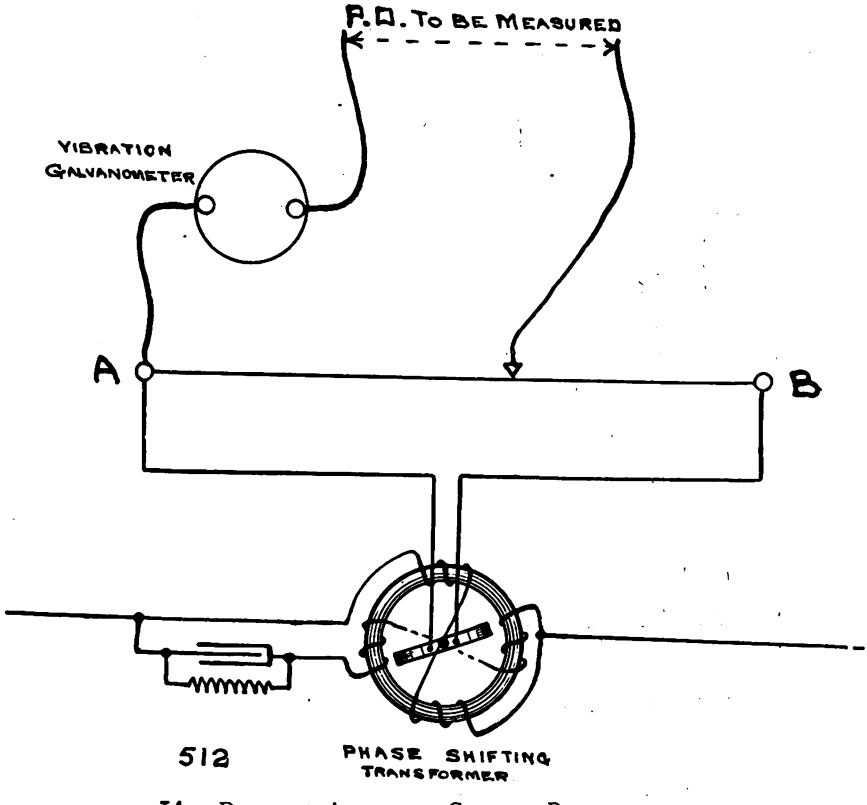
The ends of the leads from the end A of the slide wire and the sliding contact are applied to the points between which the potential difference has to be measured.

The alternating current through the slide wire is obtained from the generator through a special transformer known as the "phase shifting transformer." This consists of an iron ring wound with four coils at the extremities of two diameters at right angles to one another. The opposite coils are joined in series, so that the magnetic field, due to one pair of coils, crosses the ring at right angles to the field due to the other pair of coils. The current from

Digitized by Google

the alternator is passed through these coils, but by means of the shunted condenser shown the phase of the current in one pair of coils is arranged to lead on the phase of the current in the other pair of coils by 90°.

Consequently the two alternating magnetic fields across the ring differ in phase by 90° and they therefore combine together to form a resultant field of constant magnitude along a diameter of the



14.—Drysdale Alternate Current Potentiometer.

ring, which resultant field rotates with constant speed. If, therefore, a fixed coil be placed in the ring with its plane normal to that of the ring, this rotating field will cause an alternating electromotive force of constant magnitude to be set up in the coil. By rotating the coil about the axis normal to the plane of the ring the phase of the alternating electromotive force induced in it can be varied.

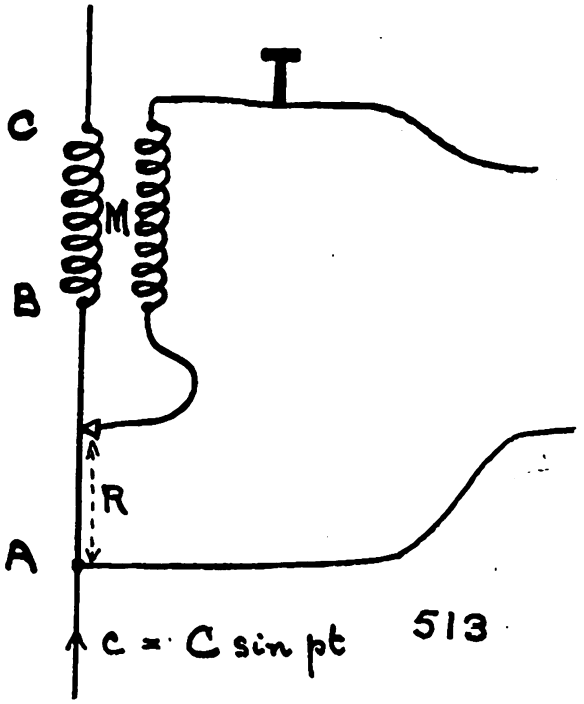
Thus the phase of the current along the slide wire can be altered, and the amount of the change can be read off by means of a pointer fixed to the secondary coil of the phase-shifting transformer.

The phase of the electromotive force at the ends of the testing

Digitized by Google

leads from A and the sliding contact can in this way be varied. The magnitude of this electromotive force is altered by moving the slider along the wire. When the electromotive force of the testing leads has been made equal in magnitude and phase to that under observation, no current flows through these leads. This condition is indicated by means of a vibration galvanometer placed in one of the leads. The magnitude of the electromotive force is then read from the slide-wire, and the phase from the pointer of the phase-shifting transformer.

The Drysdale potentiometer is only arranged for dealing with alternating currents of low frequency of the order 50 cycles per



15.—Larsen Complex Compensator.

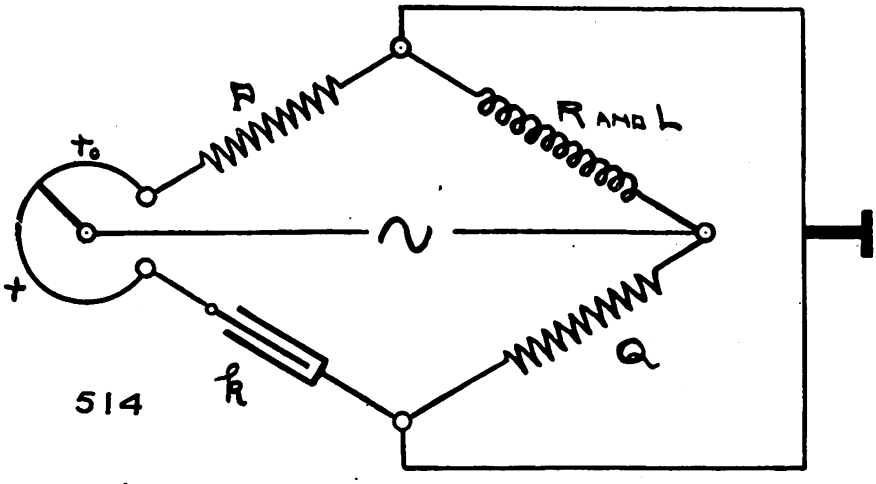
second. With currents of these frequencies, however, the deductions made from the theory of transmission can be confirmed with a remarkable degree of accuracy.

We now come to the class of measuring arrangements in which the phases are not indicated directly, but have to be obtained by calculation.

15 shows the principle of the Larsen complex compensator. The current from the sine wave generator, which is also used to provide current to the circuit under test, is passed in series through the slide-wire AB, and the primary coil BC of an induction coil with variable coupling. One end of the secondary of this induction

Digitized by Google

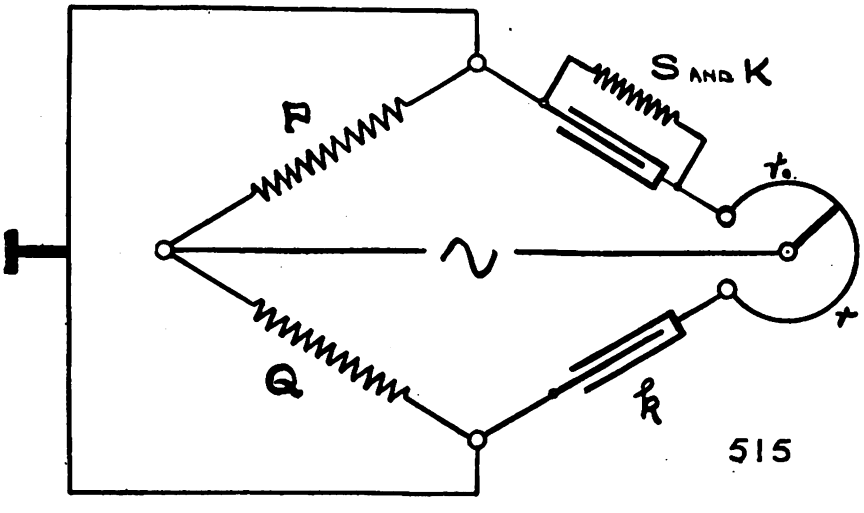
coil is joined to the sliding contact, while to the other end one of the exploring leads is connected. The other exploring lead is joined to the end A of the slide wire.



16.—HAY METHOD FOR MEASURING RESISTANCE AND INDUCTANCE.

We have a simple harmonic current flowing through ABC. Thus the current in AB follows the law $c = C \sin pt$.

If R be the resistance of the portion of the slide wire between A



17.—MAX WIEN METHOD FOR MEASURING CAPACITY AND LEAKANCE.

and the sliding contact we have the instantaneous value of the electromotive force along this portion equal to $Rc = RC \sin pt$ or a vector voltage of $R\hat{C}$.

Digitized by Google

If M be the mutual induction between the primary and secondary of the variable transformer, the instantaneous electromotive force induced in the secondary will be $M\frac{dc}{dt} = pMC\cos pt$ or a vector voltage $pM\hat{C}$ leading in phase on the voltage RC by 90°.

Hence the resultant vector voltage on the exploring leads is given by $R\hat{C} + ipM\hat{C} = (R + ipM)\hat{C}$.

The position of the slider and the value of M are varied till no sound is heard in a telephone placed in the exploring lead. In these circumstances the voltage under test is equal in magnitude and phase to $(R + ipM)\hat{C}$.

The second method of this class which will be described is the high-frequency bridge arrangement devised by Mr. C. E. Hay for measuring the resistance and inductance of a circuit.

By means of a switch the connections can be changed to those used by Max Wien for the measurement of capacity and leakance.

The connections for the two measurements are shown in **16** and **17**.

When balance is obtained, it can be shown that the following conditions obtain:

In the first case we have $L = k\frac{Q(P + r_o)}{1 + k^2r^2p^2}$

and $R = krp^2L$.

In the second case, when $P = Q$, we have—

$$K = \frac{k}{1 + k^2p^2(r - r_o)^2}$$

and $S = k(r - r_o)p^2K$.

Knowing R, L, S and K, all the other data of the circuit can be calculated.

Bibliography.

In addition to the references already given, the following may be useful to the reader desirous of studying the subject more thoroughly than has been possible in the course of this article.

"Telephonic Transmission Measurements," B. S. Cohen and G. M. Shepherd, 'Journal of the Institution of Electrical Engineers,' vol. xxxix, 1907.

"The Theory of Alternate Current Transmission in Cables," C. V. Drysdale, D.Sc., 'Electrician,' 1907, December 6th, 13th, 20th and 27th, and 1908, January 10th.

'The Propagation of Electric Currents in Telephone and Telegraph Conductors,' J. A. Fleming, M.A., D.Sc., F.R.S. Published by Constable & Co., Ltd.

'The Application of Hyperbolic Functions to Electrical Engi-

Digitized by Google

neering Problems,' A. E. Kennelly, M.A., D.Sc. Published by The University of London Press.

'Theoretische Telegraphie,' Dr. F. Breisig. Published by F. Viewig & Son, Brunswick.

"Die elektrischen Vorgänge in Fernsprechleitungen und Apparaten," Dr. A. Franke, 'Elektrotechnische Zeitschrift,' 1891, August 21st and 28th.

"Der komplexe Kompensator," Prof. A. Larsen, 'Elektrotechnische Zeitschrift,' 1910, October 13th.

ERRATA.

TELEPHONE TRANSMISSION.

Page 37, tenth line from end, should read—

$$\hat{A} = \hat{a} + \hat{b}.$$

Page 38, seventh and eighth lines from end, should read—

$$\hat{A} = a - ib$$

and $\hat{A} = Ae^{-i\theta}$

Page 39, eighteenth line from end, should read—

Then, $\hat{A} \times \hat{B} =$ . . .

Page 39, twelfth line from end, should read—

$$\frac{\hat{A}}{\hat{B}} = \frac{Ae^{i\theta}}{Be^{i\phi}} =$$ . . .

Page 220, eleventh line from end, should read—

$$\ldots = \frac{e^{x} - e^{-x}}{2}.$$

Page 220, last line, should read—

$$\ldots = \frac{i\,(e^{i\beta} - e^{-i\beta})}{2i} =$$ . . .

Page 224, eighteenth line, should read—

$$\ldots \hat{P}\hat{Y} = \frac{d\hat{V}}{dx} \cdot \delta x$$

Page 226, fifth line from end, should read—

Let $(R + ipL) = \hat{I}$ . . .

Page 226, fourth line from end, should read—

. . . becomes $\frac{d\hat{V}}{dx} = \hat{I}\hat{C}$

Page 226, third line from end, should read—

. . . . becomes $\frac{d\hat{C}}{dx} = \hat{Y}\hat{V}.$

Page 226, last line, should read—

. . . and $\frac{d^2\hat{C}}{dx^2} = \hat{Y}\frac{d\hat{V}}{dx} = \hat{I}\hat{Y}\hat{C}.$

Page 227, seventeenth line from end, should read—

. . . by $\hat{C}_0$, we have—

Page 227, sixteenth line from end, should read—

$$\hat{C}_0 =$$ . . .

Page 227, second line from end, should read—

. . . that $e^{-i\beta x}$ represents . . .

Page 229, sixteenth line from end, should read—

$$\ldots = \frac{a}{\hat{Y}}[P \sinh ax +$$ . . .

Page 230, equation (9), should read—

$$\hat{C} =$$ . . .

Page 230, fourth line from end, should read—

$$\sqrt{\frac{\hat{I}}{\hat{Y}}}$$ . . .

Digitized by Google

Page 230, last line, should read—

. . . by $\hat{Z}_0$.

Page 231, equation (13), should read—

$$\hat{C}_0 = \left[\cosh al + \frac{\hat{Z}_r}{\hat{Z}_0} \sinh al\right] \hat{C}_r \quad . \quad . \quad .$$

Page 231, equation (16), should read—

$$. \quad . \quad . \quad + \hat{Z}_r \cosh al \quad . \quad .$$

Page 231, fifteenth line from end, should read—

. . . formula $\hat{C} =$.

TRAFFIC DEVELOPMENT IN THE LONDON TELEPHONE DEPARTMENT.

By P. W. H. MAYCOCK, L.T.S.

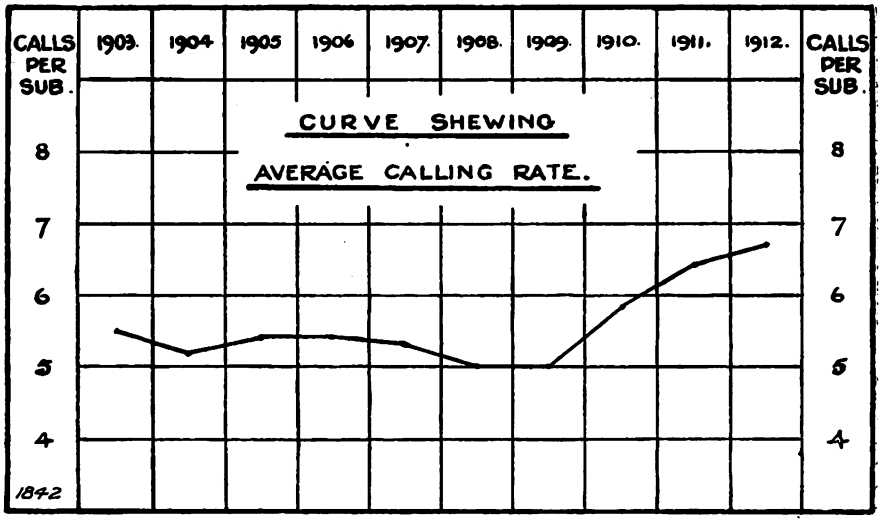
PREVIOUS issues of this JOURNAL have briefly outlined the progress of the London Telephone Department from year to year as measured by the increase in number of subscribers' lines and stations. Interesting as such statistics are, as a measure of growth, to the telephone engineer, the subscriber is chiefly interesting as a source of traffic, whose needs form the dominant factors in the successful planning of exchange equipment, and of its adjustment to the varying requirements of public use. In the April, 1911, issue of this JOURNAL some traffic statistics in respect of recent years were given; it is proposed to supplement them by a somewhat fuller statement of Post Office progress from a traffic point of view since the inauguration of the service in 1902, giving briefly one or two broad features of traffic growth, together with a description of the development of the methods followed in determining the proper adjustment of operating force to traffic conditions. The present moment is a particularly opportune one for a review of this kind. After some nine years of friendly rivalry, the systems of the Post Office and National Telephone Company have become amalgamated. Between the two systems there has always existed a very real bond of union in the fact that both have worked for the same ultimate ideal—service efficiency. It is fitting that this should be attested by the seal of corporate union, and that the two systems—one in ultimate aim—should also be one in policy and method.

Statistics, when they take the form of columns of figures, make somewhat dreary reading. In describing traffic growth, therefore, it is proposed to enlist the services of the graphic method of representation; which, in traffic and engineering matters alike, has the very real charm of extracting from the dreariest statistics the maximum amount of useful information and of presenting it, as a whole, to the mind in its most attractive and convincing form.

Digitized by Google

Applying the graphic method to illustrate growth in traffic volume past progress has been as follows:

Diagram 1 shows clearly the very steady and rapid increase in traffic volume that has taken place since the Post Office service was first established, about nine years ago. The average volume of outgoing traffic per day for the past year was 344,000 calls—more than eight times the number for 1903; and it will be seen that the average number of calls per day now is double what it was four years ago, equivalent to a rate of increase of 17½ per cent. per annum. The effect of the unsatisfactory trade conditions during 1908 and part of 1909 referred to in the article on Telephone Progress in the previous issue of this JOURNAL referred to is



1.—GROWTH OF TRAFFIC IN LONDON IN TEN YEARS ILLUSTRATED BY INCREASE IN SUBSCRIBERS' AVERAGE CALLING RATE.

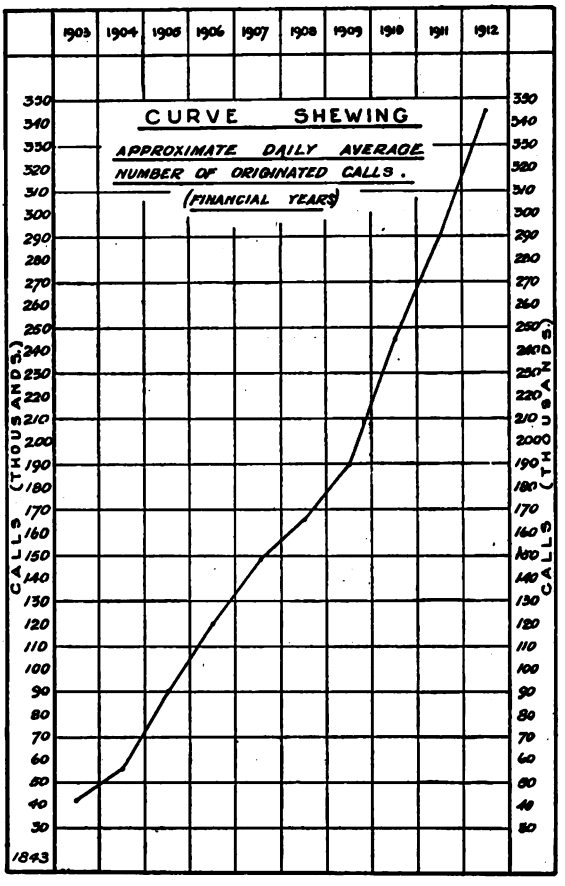
clearly evident, as also is the very marked acceleration of growth subsequently.

But from the practical traffic standpoint, the main interest in results such as the foregoing centres round growth in traffic per subscriber's line, or, as it is usually termed, the "calling rate." It is, of course, the calling rate that regulates the number of subscribers with which an operator may reasonably be expected to deal. Any variation in the calling rate, therefore, is of great and far-reaching importance, affecting both equipment and staff. Diagram 2 shows approximately the general average calling rate during the last nine years.

From the traffic point of view the curve shows features of the highest interest and significance. Between 1903 and 1909 the

Digitized by Google

calling rate remained practically stationary with a slight tendency to decrease: in 1910 and 1911 very marked increase occurred, the figures for 1911 being 28 per cent. in excess of those for 1909. With a steady calling rate, the co-ordination of staff and traffic is relatively easy; directly there is any marked and sudden increase co-ordination becomes difficult. Loads (as measured by the number



2.—Growth of Traffic in London in Ten Years illustrated by Increase in Daily Average Number of Originated Calls.

of subscribers per position) which can be taken with ease between 1903 and 1909 become in a marked degree excessive in 1911; necessitating unloading and staff increase on a scale wholly disproportionate to that which seven years' previous experience had required. The chart indicates a very marked general increase in the use of the telephone during the last three years. In the study of telephone traffic statistics it is always rash to prophesy, and often idle to speculate; but, taking all known factors into consideration,

Digitized by Google

it is hard to resist the conclusion that 1909 marks the beginning of a period of telephonic development that will tax to the utmost the resources of the united telephone organisation.

It may appear that the calling rate of the first seven years is low. But a high calling rate could not be expected, seeing that our brethren of the late National Telephone Company had ample opportunity to secure most of the large users before the Post Office commenced business. About 90 per cent. of Post Office subscribers adopted the message rate, a form of subscription which—though its advantages are undoubted—is not favourable to a very high rate of calling.

Incoming traffic has developed much on the same lines as outgoing. It does not, of course, afford nearly so good a measure of the growth of the use of the telephone among Post Office subscribers proper, and does not, therefore, in any way compare in general interest with originated traffic. No useful purpose would, therefore, be served by statistics of incoming work.

Consideration of the originated traffic per line and of its variations leads naturally to the discussion of the methods by which an endeavour is made to secure, at least approximately, co-ordination of staff and equipment with traffic. Of the fundamental points involved in the methods the most important is that of—

The Operator's Load.

When the London Telephone Department first came into being, and for the first few years of its existence, it had necessarily to work with a young and inexperienced force. In such circumstances the standardisation of loads was out of the question until practical experience had been gained of the capabilities of the force. The policy of the Department was, therefore, to open positions with a very light load, and gradually to work up the load as the efficiency of the force permitted. As experience accumulated, rough standard loads were fixed for individual exchanges.

After the expiration of some five years the Department had accumulated sufficient experience to permit the standardisation of operating loads upon a more exact basis, and accordingly studies were undertaken with the view of determining the proper operating loads for the traffic conditions obtaining in the Post Office Service. It was, of course, open to the Department to make use of the results of the very exhaustive studies conducted by other telephone administrations. But such a course would have assumed that the traffic and staff conditions in the London service were essentially similar to those of the other administrations, and it was felt that this was too great an assumption to make. Independent studies

Digitized by Google

were therefore undertaken, and it may be of interest to give some account of them. It is necessary in this section of the article to go somewhat into traffic technicalities, but to engineering readers of the JOURNAL no apology is needed for this.

OPERATOR'S LOADS "A" POSITIONS.

GENERAL PRINCIPLES: (*a*) PERMISSIBLE OCCUPIED TIME.—Given efficient operating, delay in answering a call or recall is due to the occupation on other calls of the group of operators to which the call has direct and immediate access. Assuming a constant standard of operating effort, therefore, there is a direct relationship between "occupied time" and efficiency of service; and the problem in fixing the operator's load is, broadly, to discover what is the average proportion of an operator's time that may be fully occupied without detriment to the required standard of service efficiency. The standard of service efficiency, therefore, must first be decided upon.

The elements of service efficiency being numerous, it is impossible to express any specified standard of service efficiency in a formula at once simple and fully comprehensive. Experience shows, however, that traffic conditions which permit a five seconds' "answer" and "clear" during the busy hour without operating strain produce a service which gives general satisfaction to subscribers. It is required, therefore, to ascertain what proportion of an operator's time may be occupied without detriment to this standard.

The methods adopted by the Post Office London Telephone Department in ascertaining the permissible occupied time of an operator were as follows:

(1) To ascertain by means of the observation tables the quality of service given by operators of varying ability under varying loads (occupied time).

(2) To ascertain the average minimum, general average, and average maximum load under the given conditions, noting any individual variations from the given standard of service efficiency.

Observations on these lines showed that even a junior operator of average ability may be fully occupied for an average of 47·5 per cent. (say 50 per cent.) of her time during the busy hour without detriment to the required standard of service efficiency; while in the case of the highly efficient and experienced operators an average of 64·7 (say 65 per cent.) fully occupied time is permissible.

It may appear at first sight that the proportions of "unoccupied time" involved in these loads are high. But the percentages represent average figures, and observations show that in practice there is

Digitized by Google

wide variation from the average in individual instances however carefully positions are loaded. Variations in traffic pressure of between 25 and 40 per cent. from the standard average are of frequent occurrence, and an average load equivalent to 65 per cent. "occupied time" may involve 90 per cent. "occupied time" on individual occasions. Since the Post Office standard of service should be maintained even during the busiest of the busy hours the average loads must be fixed at figures which will permit satisfactory handling of these traffic fluctuations. It is clear that loads involving 90 per cent. fully occupied time can only be taken efficiently by operators of great ability, and for very short periods only.

Since operators are of varying degrees of experience and ability, and the proportion of fully experienced operators varies at different exchanges, it is obvious that insistence upon the maintenance of anything like a rigid average load cannot logically be defended. Such an average should only result in an underload for the highly efficient and an overload for the relatively inefficient. At the same time it is very difficult to determine and impossible in practice to maintain different standard loads for different degrees of operating efficiency. Practical policy therefore requires two standard average loads:

(1) A minimum load that will be within the capacity of an efficient junior operator. To this load all should at least attain in ordinary circumstances.

(2) A maximum load that will give the telephone administration full benefit of the work of the more able operators. Beyond this load none should go with the present type of switchboard (operating team between three and four).

Between these limits the loading of individual positions can best be left to the discretion of the exchange managers, who are in a position to note more accurately the varying capabilities of individual operators. Generally it is estimated that observance of the two standards specified should produce a general average load equivalent to not less than 52 per cent. fully occupied time; and so far as it may be desirable to express the Post Office standard as a general average this percentage may be said to represent the standard "A" load.

GENERAL PRINCIPLES: (*b*) THE RELATION BETWEEN LOAD AND SERVICE.—As already indicated, there is a definite relationship between load and service—given efficient operating and constant operating effort. But in practice operating effort is not a constant quantity, even in the case of a given individual in the busy hour. In the course of the observations taken to fix the standard "A" loads it was found:

(1) That up to the limits observed (90 per cent. "occupied

Digitized by Google

time") increase in load was not accompanied by deterioration of service in the case of efficient operators.

(2) That decrease in load was not accompanied by improvement in service.

(3) That the service given on noticeably busy positions was better than the service given on relatively slack positions, even after full allowance had been made for the fact that on some of the latter positions less efficient operators would be employed.

These facts clearly suggest that until the "breaking point" is reached, increase in load has no appreciable effect on service efficiency; and that it is better to load an operator to the maximum consistent with absence of undue strain than to fix any lower load. The above deductions from observation are in accord with the facts of common experience. An operator—like any other human being—automatically and almost unconsciously adjusts her efforts to the requirements of the situation. When traffic conditions call for the maximum effort to prevent delay, that effort is made; when traffic can be efficiently handled at less than the maximum speed of working less effort is made to attain high speed. It does not follow, therefore, that if a certain load can be handled efficiently with given answering time, quicker answering will necessarily be secured with a smaller load; nor that progressive reduction of that load will result in progressive improvement in the speed of answering. To assume that an operator will work at her maximum speed when the traffic can be handled without trouble to her subscribers at less than the maximum speed is wholly at variance with the facts of experience. The Post Office system of loading, therefore, does not purport to specify loads for the various answering times above the standard; on the other hand it is not concerned to ascertain the loads implying answering service below the standard.

"A" Loads at Post Office Exchanges.

While the standard "A" loads are properly expressible in the terms of "occupied time," in applying them to individual exchanges it is convenient for purposes of traffic study to express those standards in terms of actual calls. It is necessary, therefore, to specify the various types of call dealt with on the Post Office system, together with their operating time-values (manipulative values).

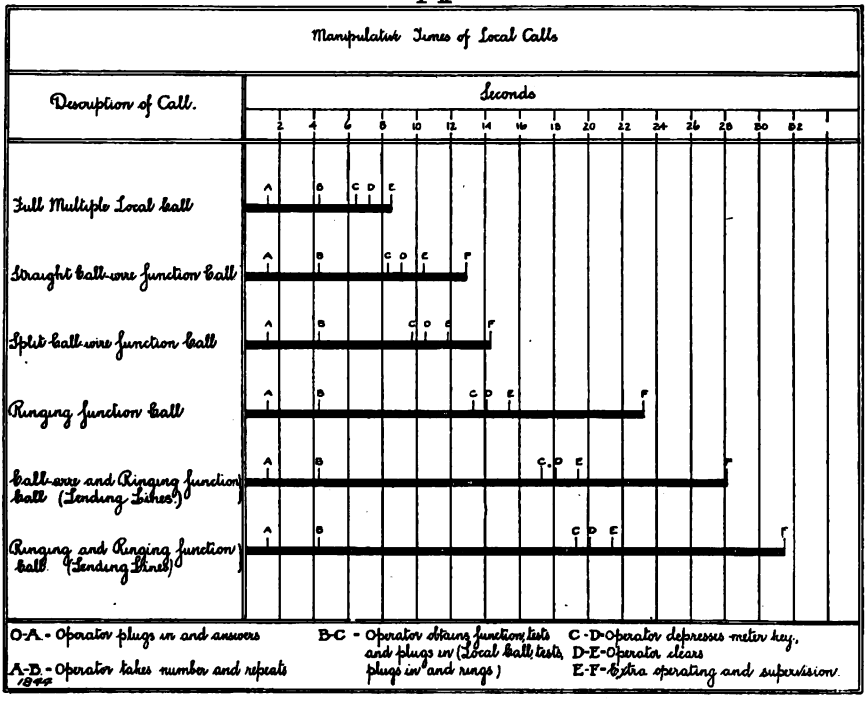
Broadly, there are nine different types of calls dealt with at Post Office exchanges. Their descriptions and manipulative values are as follows:

Description of call.	Time value (seconds).
Local call (full multiple C.B.)	8·5
Local call (small exchanges)	12·5

Digitized by Google

Description of call.	Time value (seconds).
*Straight call-wire junction	12·94
*Split call-wire junction	14·36
*Ringing junction	23·2
*Call wire and ringing junction (lending lines)	28·1
Ringing and ringing junction (lending lines)	31·5
*Tandem junction	16·94
Money-box calls	23·85

A


Manipulative Times of Local Calls
Description of Call.
Seconds
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32
Full Multiple Local Call
Straight Call-wire Junction Call
Split Call-wire Junction Call
Ringing Junction Call
Call-wire and Ringing Junction Call (Lending Lines)
Ringing and Ringing Junction Call (Lending Lines)
O-A - Operator plugs in and answers
A-B - Operator takes number and repeats
B-C - Operator obtains junction; tests and plugs in (Local Call: tests plugs in and rings)
C-D Operator depresses meter key.
D-E Operator clears
E-F Extra operating and supervision.

3.—TIME OCCUPIED IN MAKING VARIOUS TYPICAL CALLS SHOWN GRAPHICALLY.

In the case of the six principal classes of call the manipulative value of each of the various operating steps into which a call is divided has been ascertained by stop-watch observations. The results of these observations are shown diagrammatically in Statement A (3).

It will be seen at once that calls differ widely in operating time-value, and that the average time-value of a junction call is dependent upon the nature of the junction equipment of the exchange from which it originates. The manipulative value of the "average call" at an individual exchange obviously depends upon the ratios of the various classes of calls to its total traffic. Where the propor-

Digitized by Google

tion of the more time-absorbing calls is high, the value of the average call is high ; where the proportion of the time-absorbing calls is low the manipulative value of the average call is also low. The value of the average call at the various Post Office exchanges ranges from 13·66 seconds at Central to 30·29 seconds at Burgh Heath.

In the Post Office service the average percentage of junction calls is about 80, hence the value of the average call depends almost entirely upon the junction equipment of an exchange. The nature and extent of such equipment is continually altering at all growing exchanges, hence the average call values must be recognised as subject to constant revision. It is the intention that records should be taken at least once a year—preferably every six months—at all exchanges to ascertain the percentages of the various classes of call, and that not less than five days' traffic should be analysed for this purpose.

The provision of ancillary equipment or of any device which increases the size of the effective operating team will, of course, permit increase of the load standards set forth herein. The extent of that increase can be most satisfactorily determined by working experience of the ancillary equipment.

"B" Positions: General Principles.

"B" or incoming junction positions fall naturally into two well-defined divisions.

(*a*) Positions dealing with junctions and calls from one exchange only (straight call-wire positions), and—

(*b*) Positions dealing with junctions and calls from more than one exchange (split call wire and ringing positions).

Experience shows that there is a marked difference in the traffic conditions and in the loads usually carried on these two classes of positions, although in the case of all call-wire positions the operating method is uniform. In the case of straight call-wire positions the load capacity of the operator may be reached before the load capacity of the available position equipment; in the case of split call wire and ringing positions the load capacity of the available position equipment is usually reached before that of the operator. The problem of the standardisation of "B" loads, therefore, requires investigation on two different points :

(*a*) To ascertain the average number of calls the average "B" operator *can handle* efficiently during the busy hour.

(*b*) To ascertain the average number of calls *an operator receives* under split call wire and ringing conditions.

That is to say, the main determining factor in the case of straight call wire positions is the load capacity of the operator ; in the case

Digitized by Google

of split call wire and ringing positions it is the load capacity of the junctions.

Unlike an "A" operator the "B" operator on call-wire positions only receives one call at a time. Her traffic is "lined up," and during busy periods it approximates to a continuous and steady flow. So far as the "B" operator alone is concerned, therefore, conditions are favourable to a high percentage of "occupied time." But inasmuch as an "A" operator's ability to handle traffic very largely depends upon the degree to which she receives instant attention and accurate work from the "B" operator, it is essential that the standard average "B" loads should be fixed at figures which will permit practically instant allotment of junctions and the maximum accuracy of connection on the part of "B" operators. To these latter conditions all other circumstances must be subordinated.

"B" Loads: Straight Call-wire Positions.

Experience shows that the maximum average load that can be handled by a "B" operator with maximum efficiency under standard machine-ringing conditions is 500 calls in the busy hour. This load is well within the capacity of an efficient "B" operator, loads 60 per cent. and 80 per cent. in excess having actually been handled by operators of exceptional ability at periods of exceptional pressure. The standard average busy hour load in cases where the number of calls dealt with is dependent upon the load capacity of the operator rather than that of the available position equipment is therefore 500 calls; and it is found that the traffic conditions favourable to this load are usually first experienced on junction groups served by three call wires (70–80 lines). The restrictive effect of size of junction group—referred to more fully later—is slightly felt in the case of groups served by two call wires and by one call wire, necessitating some reduction in the load expected.

The approximate average manipulative time of a "B" call-wire junction call with ordinary machine-ringing is about 5·5 seconds, hence a load of 500 calls represents 76·5 per cent. fully occupied time. The standard busy hour loads required by experience for straight call-wire "B" positions, and the percentages of occupied time represented by these loads are as follows:

		Calls.		
Junction group served by	3 or more call wires	500	76·5	per cent. occupied time.
	2 call wires	480	73·25	" " "
	1 call wire	430	65·7	" " "

These loads should permit the required standard of service efficiency, and at the same time provide a reasonable load for the average "B" operator.

Digitized by Google

"B" Loads: Split Call-wire and Ringing Positions.

As already stated, experience reveals a marked difference between the average loads handled on straight and split call-wire positions, the latter showing pronounced reduction. This decrease in load must be due to one or both of these causes.

(1) Increased manipulative value of the call.

(2) Reduction in the amount of traffic received on the position.

While there may be some slight increase in the manipulative value of the call consequent upon the necessity for differentiation from adjacent junction groups, a few minutes' observation of the working of an efficient "B" operator at a split call-wire position will show that so far as the labour of handling a call is concerned, the difference between a straight and a split call-wire position is practically negligible. Certainly it is too slight to explain the decrease in load.

It is clear, therefore, that the decrease in load must be due to the reduction in the amount of traffic received on split call-wire positions as compared with straight call-wire positions; and the analysis of the traffic conditions obtaining on split positions will at once reveal reasons why such a result should obtain.

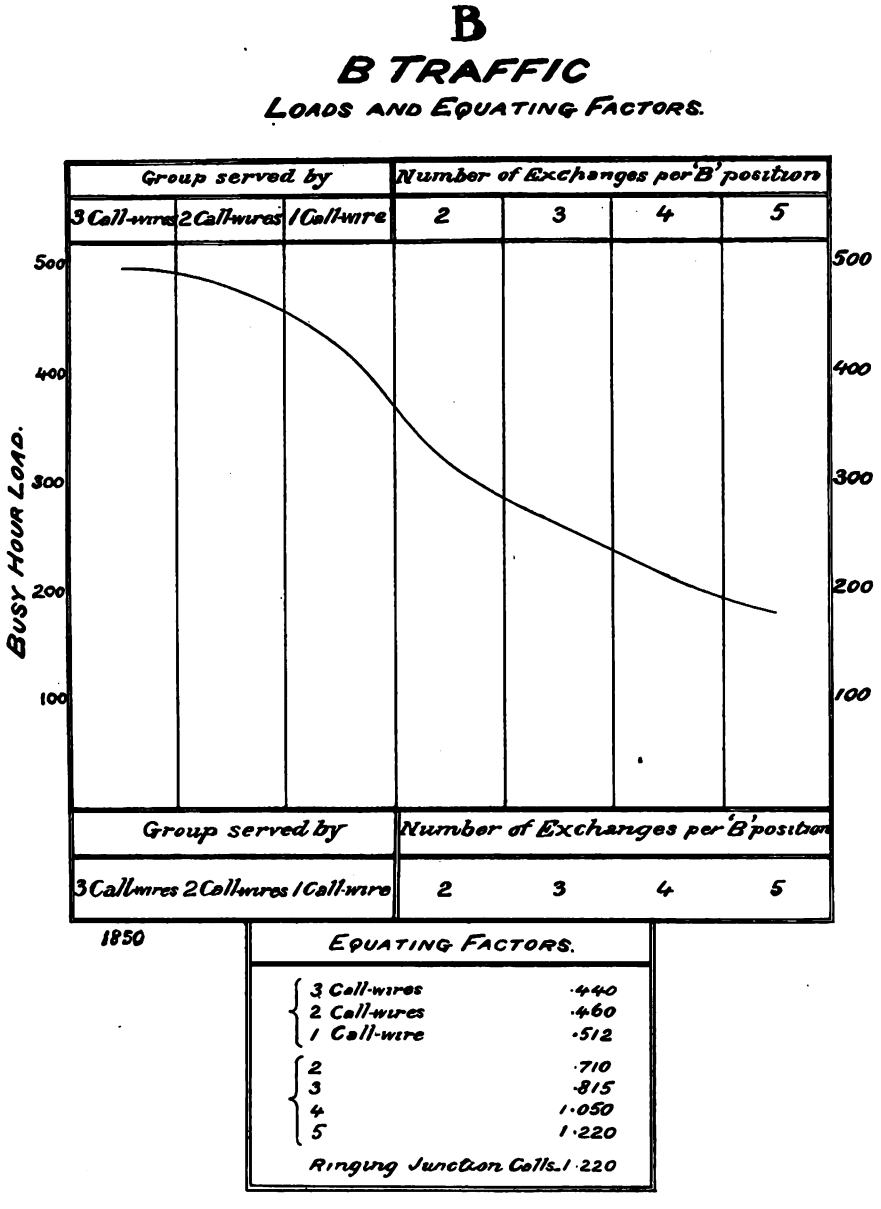
Experience shows that with a given standard of junction-service efficiency, the average number of calls a junction can carry during the busy hour increases with the size of the group of which a junction forms part. This increase in the load capacity per junction is very marked in the case of groups of up to thirty or forty lines, the load of a homogeneous group of twenty-four call-wire junctions, for example, being about 40 per cent. greater than the aggregate load of four groups of six junctions.

Since the average load per junction increases with the size of the group, subdivision of the "B" position equipment of twenty-six or twenty-eight lines into a number of independent groups necessarily reduces the load capacity per junction; the greater the number of subdivisions the lower the position load that can be expected. Hence with a uniform cord equipment there must be a progressive reduction in the traffic received on a "B" position as the number of exchanges from which it receives its traffic increases.

In addition to restriction in the amount of traffic received, there are other circumstances tending to restrict the load that can be handled on a split call-wire position. The greater the number of exchanges served by a position the greater the chance of transmission difficulties; and even if the position cord equipment were increased these difficulties strictly limit the number of exchanges that can be served from one "B" position. And apart from this there will usually be a certain margin of cord equipment "spare" for

Digitized by Google

future growth. The standardisation of loads for split call-wire and ringing positions must, therefore, be primarily determined by—



4.—CURVE SHOWING THE VARIATION IN THE CAPACITY OF GROUPS OF JUNCTIONS.

(1) The average size of the junction group in the case of split call-wire positions serving two, three, four, and five exchanges under

Digitized by Google

existing working conditions, the term "group" meaning the number of junctions incoming from one exchange.

(2) The average loads which in ordinary course are carried by groups of the sizes ascertained.

Investigation shows that the average size of the junction group in the Post Office system under the conditions specified varies as follows:

2 exchanges per "B" position	10·85
3 " " "	7·1
4 " " "	4·4
5 " " "	3·2

The average loads carried by groups of the sizes stated are shown by the curve in diagram (B [4]). Taking these loads and applying them to the split call-wire positions the following results, which may reasonably be expected, are obtained:

	Size of average group.	Load capacity per junc. (Calls.)	Busy-hour load. (Calls.)
2 exchanges per "B" position	10·85	14·3	310
3 " " "	7·1	12·7	270
4 " " "	4·4	11·9	210
5 " " "	3·2	11·2	180

The average number of working lines per ringing junction position is 18·6. The standard busy-hour load per ringing junction is 10, hence the normal load of a ringing position should be about 180 calls.

Summarising the foregoing, the standard busy hour "B" loads of the Post Office service are as follows:—

		Calls.
Junction group served by	3 call wires or more	500
	2 call wires	480
	1 call wire	430
Number of exchanges per "B" position.	2	310
	3	270
	4	210
	5	180
Ringing positions		180

The foregoing loads assume ordinary machine-ringing (manual depression of ringing key); the introduction of keyless ringing will of course require re-adjustment of the standard "B" loads when actual working experience has shown to what extent keyless working and increased cord equipment per position permits expectation of increased load.

The basis of the Post Office loads is essentially empirical. Mathematical computation of permissible load based on the theory

Digitized by Google

of probability cannot take into account the psychological elements of the human factor. The actual observation of work performed under normal conditions, provided such observation is extensive, cannot fail to take sufficiently into account all such elements; it therefore affords the safer foundation.

Comparison of Traffic Results—the Equation of Calls.

The standard loads under the various operating conditions having been fixed, it is necessary to devise a system by which it can readily be determined how closely these standards are approximated. Such a system must permit at one and the same time significant comparison between the work of the individual exchanges and the standard; and also between the work of the various exchanges. It should furnish a basis for the critical study of operating efficiency, and of the traffic efficiency of exchange equipment.

In studying the efficiency of operating, it is required to measure the amount of work performed by the operators during the busy hour; in studying the traffic efficiency of plant, it is required to measure the actual volume of traffic that can be handled efficiently during the busy hour at different exchanges. As already shown, the manipulative value—or work value—of the average "A" call at different exchanges varies widely, according to the difference in operating facilities. The "average call" at Central represents $\frac{1}{137}$ of an operator's standard work during the busy hour, while the average call at Barnet represents $\frac{1}{62}$ of an operator's work. Yet the Barnet operator in handling 62 calls is doing quite as much work as the Central operator in handling 137 calls. Since, then, the "average call" has different work values at different exchanges, it clearly cannot constitute any measure of operating work. Moreover, this varying value necessitates separate standard loads for each exchange so long as the standard loads are expressed in terms of calls actually handled at different exchanges. For the purpose of studying operating efficiency, therefore, it is necessary that the standard load should be expressed in terms of some traffic-unit of approximately constant work value; and that means should be provided for expressing in terms of that unit-standard, the traffic handled under the various operating conditions obtaining in practice. There must be some method of reducing traffic to a common denominator.

The traffic-unit in the case of the London Post Office Telephone Service is the full multiple local call at a standard C.B. exchange. This is the simplest type of outgoing call, and its work value is practically constant. It is the unit chosen by the Associated Bell

Digitized by Google

Companies in America. The operating time value of this unit call on the Post Office system is 8·5 seconds.

The Equation of "A" Traffic.

Expressed in terms of the unit, the "A" load standards of the Post Office system are as follows:

Maximum 64·7 per cent. occupied time = 2330 secs. = 274 units.
Average 52 per cent. ,, ,, = 1870 ,, = 220 ,,
Minimum 47·5 per cent. ,, ,, = 1710 ,, = 200 ,,

Statement C shows the method of expressing in terms of the unit the actual traffic handled at the various exchanges of the Post Office system. It will be seen that by ascertaining the unit value of the percentages of the various types of call at the different exchanges a single multiplier is obtained for each exchange which can be applied to any given load at that exchange. The multiplier is, of course, the unit value of the "average call." This method of traffic equation will give equivalent loads in unit calls with sufficient accuracy for all ordinary purposes, so long as the percentages are corrected at least once a year. If practicable once every six months is preferable.

A very good alternative method of ascertaining the "A" equating factor is to keep selected operators of representative ability continuously employed during several busy half hours by transferring to them calls from adjacent positions, carefully timing by stop-watch any unoccupied moments the operators may have, and the total number of calls handled. Having obtained these figures, the value of the average call is found by subtracting the total unoccupied moments from the total period of observation, and dividing by the number of calls observed. The equating factor is obtained by dividing this result by the value of the unit call, viz. 8·5. The efficacy of this method depends upon the possibility of getting the operators under observation to maintain their ordinary speed of working. There is a tendency for an operator under such conditions to work faster than she would under ordinary circumstances. An essentially similar method is employed to ascertain the average duration of junction occupation, and in that connection it is known as the idle plug count.

It will be clear from inspection of statement (C) that whereas equated loads constitute measures of operating efficiency, the equating factors themselves constitute measures of the traffic efficiency of the exchange equipment. The more complete the facilities for handling traffic the smaller the equating factor required to express the difference between the conditions accompanying the handling of that traffic and the ideal operating conditions normally accompanying the operation of a full multiple C.B. local call.

Digitized by Google

C.—Equation of "A" Traffic, May, 1911.

Statement showing Percentage of Various Classes of Calls, Manipulative Value of "Average Call," and Equating Multiplier for Exchange.

Description of call.	Time value (secs.).	Unit equivalent.	Barnet.		Burgh Heath.		Central.		Chiswick.		City.		Croydon.	
			Per cent.	Value (secs.).	Per cent.	Value (secs.).	Per cent.	Value (secs.).	Per cent.	Value (secs.).	Per cent.	Value (secs.).	Per cent.	Value (secs.).
Full multiple C.B. local	8·50	1·00	—	—	—	—	—	—	—	—	—	—	18·70	152·00
Local (small exchanges)	12·50	1·47	16·45	205·00	28·00	350·00	—	—	—	—	—	—	—	—
Straight call-wire junction	12·94	1·52	—	—	—	—	85·22	1100·00	19·10	247·00	51·40	665·00	—	—
Split call-wire junction	14·36	1·69	1·56	24·28	—	—	9·26	132·90	27·00	388·00	37·80	543·00	28·60	410·20
Ringing junction	23·20	2·73	35·70	829·00	9·82	228·00	4·40	102·00	43·18	1006·00	5·20	120·50	23·00	534·00
Call-wire and lending junction	28·10	3·30	34·70	975·00	—	—	·17	4·78	2·62	73·70	4·30	120·80	26·70	750·00
Ringing and lending junction	31·50	3·70	8·26	260·00	60·50	1910·00	·53	16·70	4·14	130·50	·40	12·60	2·68	84·50
Money-box	23·85	2·80	3·53	84·40	1·74	41·60	·41	9·78	3·85	91·80	·90	21·40	·02	·47
Tandem call-wire	16·94	1·95	—	—	—	—	—	—	—	—	—	—	—	—
Total manipulative time for 100 calls			—	2377·68	—	2529·60	—	1366·16	—	1937·00	—	1483·30	—	1938·17
Average value of call exclusive of ticketing			—	23·77	—	25·29	—	13·66	—	19·37	—	14·83	—	19·38
Add five seconds where tickets are required			—	5·00	—	5·00	—	—	—	5·00	—	—	—	—
Total average value of call			—	28·77	—	30·29	—	13·66	—	24·37	—	14·83	—	19·38
Equating multiplier for exchange			—	3·38	—	3·56	—	1·61	—	2·86	—	1·74	—	2·27

Digitized by Google

Since junction facilities necessarily vary widely at different exchanges, the work value of the junction call necessarily varies. It is therefore incorrect and misleading to attempt to value the traffic of an individual exchange on the basis of a general average ratio of the value of a local and a junction call.

The Equation of "B" Traffic.

For simplicity of system and facility of comparison of operating results it is clearly desirable that both "A" and "B" loads should be expressible in terms of the same unit. There is, however, an obvious difference in the basis of "A" and "B" loads.

The work an "A" operator can perform efficiently during the busy hour is essentially dependent upon her ability to handle traffic, and the equation of "A" loads to the unit is essentially an equation of manipulative times. On the other hand, "B" loads—for reasons already given—are in many instances fixed without regard to manipulative times. Hence the basis of the equation of "B" traffic must differ from that of "A" traffic.

A common denominator for "A" and "B" work may be found in the fact that both on the "A" and "B" side an operator is performing standard work when she is handling standard loads, however those loads may differ in the number and manipulative value of the actual traffic units handled. Though the "B" operator may handle 500 calls in the busy hour, her standard of work is neither more nor less than that of an "A" operator handling an average of 220 units. The equation of "B" traffic must, therefore, be essentially an equation of loads and not of manipulative times. The need for a maximum and minimum load does not arise in the case of "B" work as a whole. Hence "B" loads must be equated to the standard average load of 220 units.

Since a "B" operator in handling a standard "B" load of 500 calls only performs work equivalent to that of an "A" operator handling 220 unit calls, the "B" load of 500 calls must be multiplied by the ratio $\frac{220}{500}$ or ·44, in order to express it in terms of the "A" load.

On this basis the equated "B" loads will be as follows:

		Standard B load calls.	The equating factor.	Unit load.
Junction group served by	3 call wires or more	500	·44	220
	2 ,, ,,	480	·46	220
	1 call wire	430	·51	220
Number of exchanges per "B" position.	2	310	·71	220
	3	270	·81	220
	4	210	1·05	220
	5	180	1·22	220
Ringing positions		180	1·22	220

Digitized by Google

As in the case of "A" traffic, it is desirable to obtain in respect of each exchange a single factor, which, while it permits easy valuation of "B" traffic, takes into account the various operating conditions. Statement D shows the equating factors now required. They are obtained in a similar manner to the "A" factors, and the percentages require revision at similar intervals.

Loads outside the Busy Hours.

The standard loads dealt with in the foregoing pages are essentially busy period loads, and are only applicable when all working positions are staffed. It remains to fix standards for the rest of the operating day.

Experience shows that directly the staff at the board becomes less than the number of working positions the load efficiency of the operating force decreases; and this decrease in load efficiency is progressive as the average number of positions per operator increases. The extent of this progressive loss of load efficiency has not yet been fully investigated in the Post Office service; but the observations taken furnish results so far in accord with those obtained in America that the empirical curve used by the New York Telephone Company (diagram E) has been brought into use provisionally. This curve gives the proper standard loads per operator that may be expected when an operator is dealing with more than one position.

Since the staff at the switchboard of an exchange is regularly increased or reduced day by day as the traffic rises or falls, while the number of working positions steadily increases, it is obvious that outside the busy periods—when all positions must be staffed—the ratio of operators to working positions at any exchange is continually varying; and that consequently outside the busy periods the proper standard load changes from hour to hour. Since it is impossible to make any useful comparison of operating results with a continually changing standard, it is necessary for purposes of traffic study to provide means whereby traffic handled outside the busy hours can be expressed in terms of the standard average busy-hour load. In other words, it is necessary to provide a system for making proper allowance for the introduction of more difficult operating conditions.

The method adopted is essentially similar to that followed in the equation of "B" traffic, that is, an equation of loads. The standard unit load when an operator is handling three positions (for example) is 170 calls. But having regard to the operating conditions, this reduced load involves as much operating effort as 220 units in the busy hour. Therefore, to express in terms of the busy hour load traffic handled when an operator is dealing with three positions, the

Digitized by Google

D.—Equation of "B" Traffic.

Derivation of Multipliers.

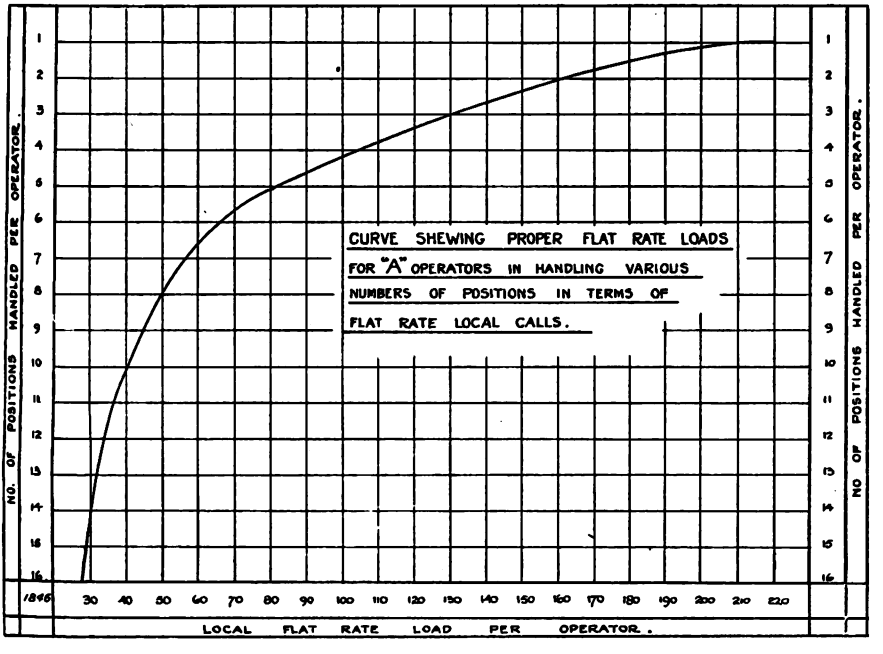
Description of call.	Unit equiv.	Barnet.		Central.		Chiswick.		City.		Croydon.		Ealing.	
		Per cent.	Value.	Per cent.	Value.	Per cent.	Value.	Per cent.	Value.	Per cent.	Value.	Per cent.	Value.
Junction group served by Over 3 call-wires	·44	—	—	50·00	22·00″	—	—	—	—	—	—	—	—
Junction group served by 3 call-wires	·44	—	—	8·35	3·67″	—	—	—	—	—	—	—	—
Junction group served by 2 ,,	·46	—	—	10·50	4·83″	—	—	36·40	16·75″	—	—	—	—
Junction group served by 1 ,,	·51	19·00	9·70″	14·30	7·30″	—	—	32·90	16·80″	—	—	13·10	6·68″
No. of exchanges per "B" position. 2 exchanges	·71	—	—	10·15	7·20″	3·57	2·53″	13·50	9·57″	—	—	—	—
No. of exchanges per "B" position. 3 ,,	·81	—	—	3·90	3·14″	—	—	8·67	7·02″	41·00	33·20″	—	—
No. of exchanges per "B" position. 4 ,,	1·05	—	—	·98	1·03″	—	—	—	—	—	—	—	—
No. of exchanges per "B" position. Over 4 exchanges	1·22	—	—	—	—	42·40	51·70″	—	—	—	—	—	—
Ringing junction calls	1·22	81·00	98·80″	1·75	2·14″	54·00	65·90″	7·90	9·65″	59·00	72·00″	86·80	105·90″
Total unit value of 100 calls	—	108 50″		51·31″		120·13″		59·79″		106·20″		112·58″	
Unit value of average call and equating multiplier for exchange	—	1·08		·513		1·20		·59		1·06		1·12	

Digitized by Google

traffic dealt with, after expression in terms of the unit, must be multiplied by $\frac{220}{130}$ or 1·69.

From the curve in diagram E, see 5, the proper unit loads for various numbers of operators at switchboards of various sizes up to 100 positions have been calculated together with the equating factors required to express in terms of the standard average busy hour unit load traffic handled under the varying conditions. Statement F gives an example of the method adopted. The calculations are approximate only, but of sufficient accuracy for all ordinary practical

E.


CURVE SHEWING PROPER FLAT RATE LOADS
FOR "A" OPERATORS IN HANDLING VARIOUS
NUMBERS OF POSITIONS IN TERMS OF
FLAT RATE LOCAL CALLS.
NO. OF POSITIONS HANDLED PER OPERATOR.
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
1896
30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220
LOCAL FLAT RATE LOAD PER OPERATOR.

5.—Curve showing Proper Flat Rate Loads for "A" Operators in handling various Numbers of Positions in Terms of Flat Rate Local Calls.

purposes. Since traffic conditions are subject to constant variation, it is neither possible nor desirable to apply any rigid standard in the criticism of traffic results.

From the foregoing it will be seen that in studying the co-ordination of staff and traffic the Post Office system of equated call values subjects the "actual" traffic handled hour by hour to a double equating operation.

(1) The reduction to unit calls of the actual calls handled (applying the equating factors shown in statement C or D as the case may be).

(2) The expression in terms of the busy hour standard average load of such of the unit loads obtained in (1) as may have been

Digitized by Google

F.—Statement showing Proper Loads when the Number of Operators at the Board is Less than the Number of Positions.

Number of Working Positions in Exchange.

Number of operators.	2.			3.			4.		
	Calls per operator.	Total equated load.	Factor.	Calls per operator.	Total equated load.	Factor.	Calls per operator.	Total equated load.	Factor.
1	160	160	1·37	130	130	1·69	105	105	2·10
2	220	440	1·00	180	360	1·22	160	320	1·37
3	—	—	—	220	660	1·00	190	570	1·15
4	—	—	—	—	—	—	220	880	1·00
5	—	—	—	—	—	—	—	—	—
6	—	—	—	—	—	—	—	—	—
7	—	—	—	—	—	—	—	—	—
	5.			6.			7.		
1	80	80	2·74	65	65	3·39	55	55	4·00
2	145	290	1·52	130	260	1·69	115	230	1·92
3	175	525	1·25	160	480	1·37	152	456	1·42
4	195	780	1·13	180	720	1·22	170	680	1·29
5	220	1100	1·00	195	975	1·13	185	925	1·19
6	—	—	—	220	1320	1·00	200	1200	1·10
7	—	—	—	—	—	—	220	1540	1·00

handled when the number of working positions exceeded the number of operators (applying the appropriate equating factors in statement F).

By this double equation the operating force receives something like full credit for its work. Without such a system it cannot receive proper credit, and unless such credit is given criticism of traffic results is illogical and misleading.

The aim of any system of traffic equation is to ensure that in all circumstances the operating force receives full credit for all necessary work; and, therefore, no system of equation can rest content until it has analysed and valued all the various details that go to make up the normal duty of an efficient operator. The system of equation now outlined does not, of course, pretend to be in any way exhaustive, and there are numerous points that will repay detailed study, but actual use has shown clearly that the system as it stands furnishes a basis for reasonable and useful criticism of traffic results and a criterion of staff requirements. It may be of interest to give

Digitized by Google

an example of the effect of the valuation of calls in the study of the co-ordination of staff and traffic.

The Use of the Equating System.

The main practical purpose of a system of traffic equation is, of course, to ensure that the staff on duty throughout the day is fully adequate to the requirements of the traffic hour by hour. Traffic is subject to considerable seasonal fluctuation, and it is necessary in order to obtain a fully comprehensive view of the service to take frequent records. Such records taken at each exchange monthly are known by the familiar term "peg count" records, though with the advent of the modern C.B. system with its automatically operated position meters the term has lost much of its old significance. It may at first sight appear that records taken at such short intervals as a month are unnecessary. It must, however, be borne in mind that systematic traffic records are required for two purposes.

(1) As a measure of traffic growth; and—

(2) As a measure of traffic fluctuation.

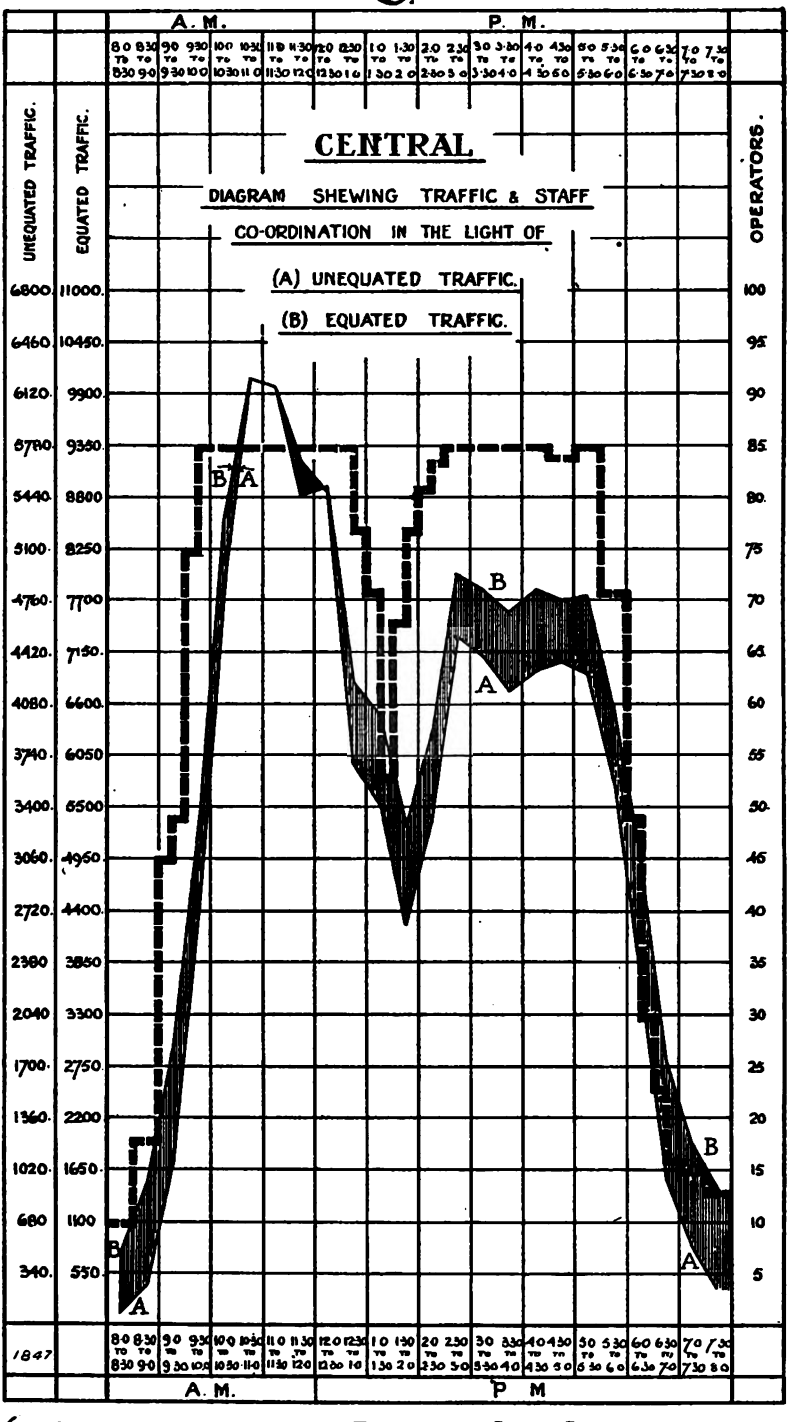
Isolated records taken at irregular intervals obviously furnish no true measure of traffic growth, while to cover seasonal variation some attempt must at least be made to ensure the records covering all seasons.

For the purposes of the peg count calls are recorded half-hourly. Originated calls are recorded on the position meters; incoming calls are recorded by means of ratchet counters. Both meters and ratchets are read every half hour, and the number of calls for each period is recorded on a form provided for the purpose; this form also shows the staff employed throughout the day. To the figures so obtained the proper equating factors are applied, and the results are shown graphically as in diagram G (6). This diagram shows the traffic at Central Exchange.

In order to show the practical value of the system of traffic equation, two load lines are shown in relation to the staff line. That marked A represents the load in actual (unequated) calls; that marked B shows the equated load. In the case of curve *a* no allowance is made for the more difficult conditions of operating which arise during the less busy hours of the day, when one operator has to deal with more than one position; curve *b* shows the same load when each call receives its proper work value; curve *b*, therefore, is a measure of the amount of work involved to the operating force. The difference between the two results is very striking. If the staffing of the exchange were judged on curve *a* it would appear to be excessive during certain periods. Curve *b* shows at once that any such appearance is entirely fallacious. Since the

Digitized by Google

G.



6.—Central: Diagram showing Traffic and Staff Co-ordination in the Light of (*a*) Unequated Traffic; (*b*) Equated Traffic.

Digitized by Google

primary object of exchange staffing is to maintain an efficient service, it is clear that without a system of traffic equation there can be no useful criticism of staff co-ordination, for without such a system calls do not receive their proper work value. In addition to facilitating the study of the co-ordination of traffic and staff at particular exchanges, the system of traffic equation permits, of course, comparison between the traffic results of different exchanges which would otherwise be impossible.

The proper criticism of traffic and staff co-ordination involves full recognition of the fact of seasonal variation in traffic pressure already mentioned. Just as the traffic of the day varies from hour to hour, so the traffic of the year varies from month to month. It will be of some interest to show graphically the extent of this seasonal variation so far as it affects the principal exchanges of the Post Office system proper. Diagram H (see 7) shows this variation graphically, and represents the traffic of each month as compared with that of the busiest month of the London season. Three features of great importance will be obvious from inspection of the diagram:

(1) That the busiest months are May, June, November and December.

(2) That variation of traffic is such that in many instances, if proper provision is made for the busiest months, the staff must necessarily be theoretically excessive in the slacker months.

(3) That the extent of the seasonal variations differs widely at different exchanges.

This question of seasonal variation of traffic is of great importance in connection with the annual leave arrangements of the exchange staff. It is obvious that a considerable reduction of the busy season force is practicable during the slacker months without detriment to service efficiency; hence by taking advantage of the traffic variation, leave arrangements can be made which are at one and the same time economical to the Department and satisfactory to the staff, since traffic conditions permit a larger number of operators taking their leave during the more attractive months of the year. It will be clear from diagram H that there is a great difference in the traffic conditions of the exchanges as regards suitability for annual leave. At Western, for example, circumstances are twice as favourable as they are at Central; and more than twice as favourable as they are at Richmond.

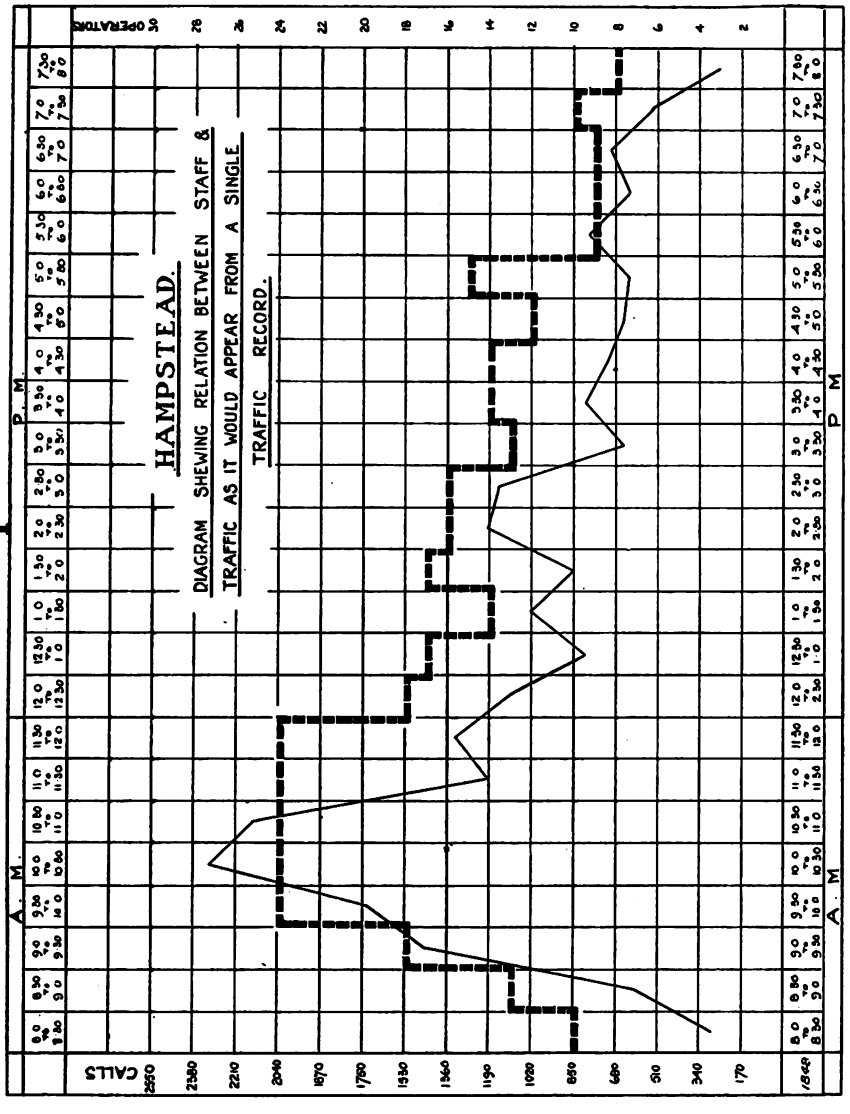
Since, therefore, the traffic of the system generally is noticeably subject to seasonal variation, it is obvious that, as previously stated, a comprehensive view of the staff requirements of an exchange cannot be determined from one isolated traffic record. The standard of service of the Post Office system is that the staff should be equal

Digitized by Google

7.—Variation in Traffic from Month to Month compared with June, the Busy Month of the London "Season."

Digitized by Google

to dealing satisfactorily with the traffic of the busiest normal day of the year. While, therefore, a single instance in which traffic is in excess of the capacity of the staff can prove staff insufficiency, no

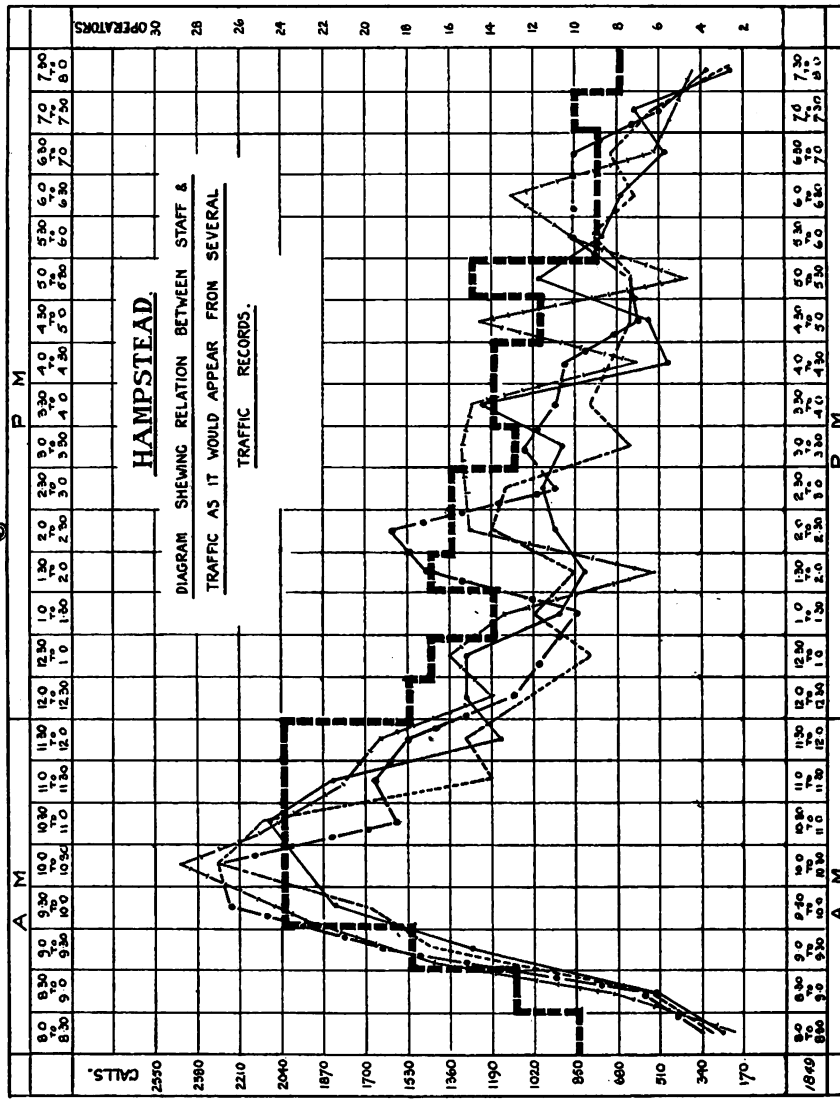


8.—Hampstead: Diagram showing Relation between Staff and Traffic as it would appear from a Single Traffic Record.

single record in which the staff appears in excess of the traffic can prove staff excess, as there is always the possibility of a busier day. Hence, to permit useful criticism of traffic and staff co-ordination a number of traffic records must be examined when considering staffing. Unless there is systematic study of a number of traffic records

Digitized by Google

when considering staff arrangements there can be no indication of the extremes of traffic variation that have to be met, and it is these extremes of variation that should determine staff allocation rather



9.—Hampstead: Diagram showing Relation between Staff and Traffic as it would appear from Several Traffic Records.

than average figures. An interesting example of the difference in the standard when an exchange staff is criticised in the light of one traffic record, and the standard when several records are employed is given in diagrams I and J (see 8 and 9). The first (diagram I) shows the Hampstead duty arrangement in relation to one traffic record; a second diagram (J) shows the same duty system in relation to a

Digitized by Google

number of traffic records. In the first case it would appear that the staff is excessive; in the second it is clear that while there may be this appearance of excess in individual instances, it is only an appearance—not a reality.

Examination of the diagrams given will show that even when the traffic receives its full work-value, it would appear in many instances that the staff is in excess of the traffic requirements. This is unavoidable. If the standard of service efficiency is to be maintained a full staff must be on duty during the busier hours. Moreover, traffic distribution throughout the day varies widely in different exchanges and is subject to fluctuations during individual hours of the day; on the other hand, the hours of duty of the operating force are to a large extent fixed and invariable, and are subject to restrictions, while the incidence of traffic cannot be controlled. In the telephone system, therefore, there is a relatively restricted and inelastic system of operating duties in combination with varied and fluctuating traffic conditions. In such circumstances co-ordination of staff and traffic is necessarily of limited and variable efficiency, and a certain amount of what may be termed "necessary waste" of force must be recognised as unavoidable. It is of course the aim of the Traffic Department to reduce this waste to the lowest limits consistent with efficiency, and an important problem in standardisation is to determine the percentage of permissible waste proper to given traffic conditions; but it is both unwise and uneconomical to attach too much importance to this point. The first condition of true economy is efficiency of service. All other considerations are of secondary importance.

It is of importance to remember when studying the co-ordination of traffic and staff at different exchanges that, generally speaking, the larger the exchange the closer the degree of co-ordination to be expected, since the larger the staff the greater the possibility of its close adjustment to the traffic. Since the percentage value of the individual operator varies with the size of the staff, it follows that the withdrawal of one operator is a very different matter in the case of a staff of five than it is in the case of a staff of 200. A staff of five cannot be reduced by less than 20 per cent.; a staff of 200 can be reduced by ·5 per cent.

The study of the proper relation of staff and traffic is of course a subject of such magnitude that it is not possible within the limits of a general traffic article to do more than touch briefly upon it. Should the subject prove of sufficient interest to readers of the JOURNAL it may be possible to deal with it more fully in a separate article. In the present instance only so much of the Department's system as is required to give an indication of the system of traffic equation has been referred to.

Digitized by Google

Discussion of the question of the standardisation of load and the equation of traffic leads naturally to the question of the development of the Post Office system of traffic statistics as a whole. It may be of interest to outline that system.

(To be continued.)

THE TELEPHONE IN THE OFFICE.

By H. M. VINCENT.

MUCH has been written in this JOURNAL about the telephone, from both the technical and commercial points of view, but, so far as the writer knows, the function of the telephone in the office has not been the subject of any article. The telephone as a potential instrument may be said to have three concentric zones of usefulness differing from each other only in the degree in which it is able to exercise its function of annihilating distance. First of all there is the outer zone represented by the trunk service, the bounds of which are steadily increasing. Contracting a little, there is the zone which has for its boundary the boundary of the local telephone area, and finally constituting the inner ring, there is the zone bounded by the four walls of the building in which the telephone is installed. It is with this latter zone that this article is concerned, and it is thought that a consideration of its elements will indicate a field of usefulness which has not yet been fully developed, and which, if developed, would result in a much higher value being obtained from the plant installed. The zone itself exists of course only in those offices where a switchboard of some kind is installed, and it reaches its greatest proportions where there is a private branch exchange. Business houses are beginning to recognise that the latter type of installation is the one which gives the most satisfactory results as a whole in exchange service and in meeting the needs of the business; and therefore these inner zones are likely to become much more numerous in the future.

In these days of big commercial enterprises, needing the housing of large staffs to carry on the business, the size of modern offices has greatly increased, and the necessary space has had to be found in building upwards rather than over a larger area. The departments or sections into which the staff is divided are all more or less interdependent, and constant daily reference has to be made between them in order to deal with the business of the firm. This entails some sort of intercommunication, and there are three ways in which this communication can be effected. First of all, the necessary information can be obtained by formally writing to the department concerned and receiving a written reply. This method is cumbersome, and, in the light of modern science, antiquated, involving unnecessary delay in coping with the business in hand. Secondly, the man who desires the in-

Digitized by Google

formation can go to the department and obtain it verbally at first hand. This is an improvement on the first method, but it has its drawbacks, due in some measure to the construction of the office in which the business is housed. In most cases it would mean walking up and down stairs at all times of the day, than which there is nothing more tiring, and a good administration will do all in its power to remove any unnecessary fatigue to the staff under its control. It necessitates the expenditure of much time which could be employed more usefully. Moreover, there is the very serious drawback to the chief of the department that the clerk is necessarily absent from his post at certain times. Both these methods have disadvantages as regards time and facility for obtaining the required information. There remains then the scientific way of obtaining the information, by telephoning to the department concerned. Such a method reduces delay to a minimum and can be made equally reliable as obtaining information at first hand.

The telephonic intercommunication of departments involves some internal system of telephones, and, in the large offices under consideration, the necessary apparatus is already installed; house telephones are expensive and unnecessary. The extension lines fitted in connection with a private branch exchange system can fill the need adequately. It requires very little observation to note that these extension lines are not overloaded. For a large part of the working day the instruments are lying idle, although they are there ready to hand and capable of rendering a most efficient aid to the conduct of the business. It is this dormant power that is in danger of being overlooked and upon which this article is intended to focus attention. Two questions at once arise. Will the information so obtained be as reliable as that obtained verbally or in writing? Experience has shown that it is; indeed, when the question is analysed it is clear that there cannot be any other answer to it, for a fact is not less a fact just because it is given over the wires. We do not question the accuracy of a telegram simply because the sender and receiver do not come into actual personal contact during the transaction. In all cases names or initials should be obtained as a safeguard in order to fix responsibility, and the clerk giving the information should make a note of the conversation for future reference. Again, will such a procedure congest the Exchange lines and interfere with the ordinary Exchange traffic? It need not. The same problem has been solved successfully in the case of trunk calls in safeguarding the traffic in the outer zone from congestion owing to local traffic. The telephonist in charge of the switchboard at the private branch exchange should have similar power to that which is given to the telephonist dealing with trunk calls, viz. of breaking in on an inter-departmental conversation where necessary and connecting the incoming call for attention. With this system properly supervised and efficiently carried out the use of the extension lines for internal communication should involve no appreciable delay to the Exchange traffic. It would need the co-operation of the heads of the business firms in seeing that their operators carried out the instructions.

The results obtainable from such a system as has been outlined may be summarised. It would make for efficiency in tending to save time and generally to speed up the methods of dealing with business cases. Promptitude is essential or else stagnation soon results. It would enable the highest possible

Digitized by Google

value to be obtained from plant which must be installed to give the ordinary Exchange service. It would tend to create the telephone habit, which would be, perhaps, one of its most far-reaching results. When we are accustomed to obtain, by telephone, information needed for the daily conduct of business, the chances are that eventually we shall feel the need of the telephone even in the daily transactions of our domestic life. The consequent growth of the telephone system would be the best possible advertisement for the administration as a whole.

In conclusion it may be said that the subject has been dealt with only in its broad outlines owing to the necessity for keeping the article within reasonable limits. I feel convinced that these outlines are sound and that it is possible to build up an efficient organisation on them, to the consequent raising of the tone of any administration which adopts them. The system needs only putting into practice to prove its worth.

MR. DOOLEY VISITS A TELEPHONE FACTORY.

"Ye know what a tillyphone is, Hinnessy—the little dingus ye lie to yer woife through when ye want to stay downtown av an avenin'? Yez call it a ''phone,' but 'tillyphone' is the roight name fer ut. It comes from the Grayk wurrd 'tilly,' manin' 'to tell,' an 'phoney,' meanin' somethin' bogus; so whin ye tell them little fibs to yer woife, ye're usin' it accordin' to Hoyle. If I was a married man, Hinnessy (which, thank the Lorrd, I am not), I wud starrt a movement to raise a monymint to the man that invinted the tillyphone. Wid a tillyphone an' six moiles av capper wire, a man kin lay down the law to his woife in a dignified way, widout havin' to go to the ixpense av buyin' a new rollin' pin aftherwards.

"I was out to Hawthorne last wake, visitin' the Westerrn Aylictric Comp'ny's place, where they make thim things. Man, man, but it's a foine place! Whin ye go in at the gate, ye are shtopped be a felly ye take fer a polaceman, until ye see thot he ain't Oirish. He wants to know who ye are an' what yer business is. I tol' him I wanted to see the place.

"'Have yez a pass?' siz he.

"'Past is it?' siz I. 'Shure, do ye have to exhibit yer family skiliton to git through these worruks?'

"'No, no,' siz he, 'Oi don't care about yer past. Oi siz "pass"—a permission to go through the plant.'

"'No, I ain't,' I siz. 'But, maybe ye could git me wan; I'm perfissor av applied electricity' (which I am, Hinnessy, fer don't I turn on me own electhric loights?).

"So I got me pass an' a guide to show me through the worruks. Wan av the things thot struck me furrst was the big clocks shtanding around iverywhere, so's the help will know whin to stop worruk. They looked loik an orthinary toimepace, except thot they had a big circle around thim, wid numbers on it, an' a handle thot ye tuk an shtabbed at the numbers wid; if yez hit the bull's-eye, ye rung a bell. An' they shure have some marksmin over there, Hinnessy. Wan after another walked up to thim clocks, an' divil a wan missed the bull's-eye.

"Siz I to me guide, 'Phwat do they all crowd in so fast for?'

"'Why,' said he, 'the 8.30 whistle has blew, an' they want to poonch in before the clocks register 8.31. Fer if they're a minnit late, they're fifteen minnites late.'

Digitized by Google

"'Wud ye moind doin' thot on paper fer me?' I asked. 'Me arithmetic ain't as spry as it was some years back.'

"'Shure,' he siz. 'I don't know how it's figgered. Thot ain't my job, but I know thim's the rooles.'

"No it luks to me, Hinnessy, loike they was infringin' on me frind Billy Bryan's copyroight. Thrue, he figgered sixteen to wan instid of fifteen to wan, but the principle's the same, an' afther all, what difference does a figger make, as the ossified man said whin he married the fat lady.

"'An' phwat kapes track av the night force?' I asked.

"'Why, thim same clocks,' siz he.

"'Thin,' siz I, 'why the divil have they got 'em labeled "Dey Time Registers?"'

"'Ye kin search me,' he siz.

"It's a moighty big force they got over there, Hinnessy—hunderds an' hunderds of gurruls, an' ivery wan chewin'.

"'Phwat are they all atin'?' I asked the felly.

"'They ain't atin',' he answered. 'They're only chewin'. Ye see, we don't allow thim to chew the rag durin' wurrkin' hours, so they takes to gum. It takes six gum factories, workin' noight an' day, to supply the T. A. buildin' alone.'

"'It's nice woide aisles ye have here,' I remarked, 'but ain't they afther bein' woider thin necessary? Ye waste space.'

"'Yis,' siz he, 'they're pretty wide now, but they was laid out whin hair was in style. Why, a few months back a man had to go through these aisles sideways an' push his shadow through ahead av 'im, to git past the coiffoors widout takin' home enough av thim on his coat to git him in throuble wid his woife. But the comp'ny cudn't git along widout the girruls. Ye know the fair sex complately outclasses us min whin it comes to conversayshun, so the comp'ny hires thim to learn the baby 'phones to talk. Why a man thryin' to butt into the conversation av our gurrul experts wudn't shtand as much chanct of gittin' a hearin' as an echo at a deaf mutes' convintion.'

"An' there's the Worruks lab'ratory, Hinnessy. Thot's a quare place. They've got all kinds av shtrange infernal machines, ay-lictrical an' chimical, to help thim in their business, which is to call an all-wise but sometimes unrooly Providence up on the cyarpet an' make it explain itsilf whin some conthraption or ither rafuses to come up to 'spec.' 'Spec.' is short for 'specifications,' which is a sort of a Bible iverywan has to live up to, over there. It's diffrunt from the old wan, though. It cuts out the Prophets intoirely. Still, it makes up fer thot by bein' extry shtrong on Commandments. But, as I was sayin', av all the quare conthraptions yez iver seen, they've got the quarest. Oi don't want to brag, but ye knows yersilf, Hinnessy, I've been in some of the foinest bar-rooms in this conthry, but niver annywheres have I seen a colliction av glassware to aqual theirn. Why, if a man took a drink of wake tay out av wan av thim twisty bottles they have, it wud take him six wakes to git his legs straightened out agin.

"But, shpakin' av twistin', Hinnessy, did ye iver see an insultin' machine puttin' insults on wires? Well, ye don't want to. It luks loike sivinteen attacks of delirium tremens thryin' to bust up a Maypole dance. If I had to luk at wan of thim machines all day, I'd sign the plidge.

"But don't ye be gittin' the notion in yer head thot machines is all there is over there. They've got a libr'y an' a band an' orchesthry, not to mintion the Men's Club, which kapes the mimbers supplied wid lectures, voddyville an' nickel shows free of charrge.

"An' they've got ball grounds an' tinnis coorts an' sick-likes fer thim as wants to amuse thimsilves at noon, an' a rist'rant fer the old-fashioned wans thot wants to ate. An' take it from me, Hinnessy, as the b'ys say now-a-days, it's *some* rist'rant. There's a siction upstairs, where ye ate on pay-day at not less thin twinty cints a throw; an' the rest av the wake ye kin ate downstairs on the Open Board, where the ante runs from a penny up to whativer you've got. Things shure are fixed up foine. Ye kin git a piece av pie wid decorayshuns on it for tin cints, an' they aven kape burrds for the eddyfication av the guests. An' mind ye, it ain't none av yer quick-lunch joints. It's genteel. I waited half an hour before I got a bite to ate at all. I made wan bad break, Hinnessy, an't it's ashamed av it I am. I ordered a steak, an' afther a bit the young lady sits down

Digitized by Google

a plate befure me. I looked at it, an' thin I siz to her, 'Beggin' yer parrdon, Miss, but it's a dirthy plate-ye've brought me.'

"'Dirthy?' siz she. 'It looks clane to me. Where's the dirrt, plaze?'

"I pointed out the spot to her.

"'Why, bless yer soul,' she siz, 'thot ain't dirt. Thot's the steak!'

"An' may ye stroike me dead, Hinnessy, if it wasn't."

"An' was the steak good?" asked Hinnessy.

"Sh-sh-sh," said Mr. Dooley. "I promised on the worrud of a gintlemin not to divulge any company secrets."—*Western Electric News.*

Digitized by Google

RECRUITMENT OF ENGINEERS.

THE following important announcement relative to the subject of future appointments to the class of assistant engineers in the British Post Office appeared in the Post Office Circular of August 6th, 1912.

PROSPECTIVE EXAMINATION FOR ASSISTANT ENGINEERSHIPS, ENGINEERING DEPARTMENT.

A limited competition for a small number of appointments on the new class of assistant engineer (scale £105–, £15–, £300–, allowance for London £20) will probably be held in about three months.

The age-limits will be:

(*a*) 21–40 for Post Office servants *with* practical engineering experience.

(*b*) 21–32 for Post Office servants *without* practical engineering experience.

Candidates must be within the prescribed limits of age on the first day of the examination.

The subjects of examination will be:

(1) English composition.
(2) Mathematics.
(3) Drawing.
(4) French or German or Italian.
(5) Applied mechanics.
(6) Electricity and magnetism.

Digitized by Google

(7) Structures.
(8) Personal qualities.

No candidate will be eligible who does not pass to the satisfaction of the Civil Service Commissioners in each of the subjects numbered 1, 2, 3, 4, 5, 6, 7, and 8.

A syllabus of the examination appears at the end of this notice.

The examination may be held in one part or in two parts, at the discretion of the Civil Service Commissioners. In the latter case the first part will be used to reduce the number of competitors to be admitted to the second part. Of those who pass and obtain the highest aggregate marks on the first part a certain number, to be determined by the Civil Service Commissioners, will be admitted to the second part of the examination. The successful list will consist of those candidates who pass and obtain the highest aggregate of marks on the whole examination.

There will be an open as well as a limited competition for assistant engineerships. The qualifying minimum number of marks will be the same for both classes of competitors, and in the event of the number of qualified candidates in either competition being insufficient to fill 50 per cent. of the vacancies offered, the deficiency will, if possible, be made up from the other competition.

The Civil Service Commissioners will require a fee of £1 from each person attending the limited competition.

All travelling expenses must be borne by the candidates.

Successful candidates will probably be required to serve a two years' probation, during which period they will receive the scale of pay of the class from which they are drawn. If at the end of the period of probation they are pronounced suitable and capable, they will be confirmed in the appointment of assistant engineer. If, on the other hand, their appointment is not confirmed, they will be returned to the class they came from, without loss of seniority.

The appointment involves liability to transfer from one part of the country to another in accordance with the requirements of the Post Office service.

A further announcement as regards the date of the examination, the period of probation, and the starting pay on confirmation of appointment as assistant engineer, will be made as soon as possible.

Syllabus.

(1) English Composition.—A short essay on some subject of general interest.

(2) Mathematics.—*Geometry:* The fixing of the position of a point (in a plane or in space) by co-ordinates, the conditions to fix figures in shape, size, and position. Properties of rectangular solid,

Digitized by Google

rectangle, parallelogram, triangle, sphere, circle, and other simple figures. Area of an irregular figure by squared paper or by approximate division into quadrilaterals or triangles, volume of an irregular solid by first finding areas of a number of parallel sections. Similar figures, proportion to be treated algebraically and all quantities to be considered mensurable. Loci. Drawing curves from given conditions, *e.g.* motion of a point of linkwork, or conditions given by equations between co-ordinates. Projection of straight line, plane figures, cylinder, cone, prism; interpenetration of these figures; sections; projection of simple helix and square-threaded screw.

Arithmetic.—The metric system, approximations and rough checks, use of logarithms, evaluation of formulas for numerical values.

Algebra.—Graphs, slope of a graph and rate of increase of function represented, solution of equations by calculation and by graphs, indices and logarithms.

Trigonometry.—The solution of triangles and allied problems.

Infinitesimal calculus.—A working knowledge of the notation and fundamental principles in so far as they can be illustrated graphically, and of the expansions in series of $(1 + x)^m$, e^x, $\log (1 + x)$, $\sin x$, $\cos x$, $\tan^{-1}x$, with simple applications to the properties of curves, to turning values, and to easy mechanical and physical problems.

(3) DRAWING.—Engineering drawing, including especially the application of graphical methods to the solution of mechanical and electrical problems.

(4) FRENCH, GERMAN AND ITALIAN.—The test will consist of translation (from the foreign language). The candidate's translation must not only show that he understands the original, but must also be expressed in good English.

(5) APPLIED MECHANICS.—The principles of statics and hydrostatics illustrated by their practical applications, including the calculation of stresses in the members of a frame and the equilibrium of floating bodies. Dynamics up to and including the rotation and oscillation of solid bodies about a fixed axis. The elements of hydraulics as illustrated in the flow of liquids through pipes, discharge from orifices, and the elementary theory of pumps and turbines.

(6) ELECTRICITY AND MAGNETISM.—The fundamental principles of the subject, especially as illustrated in the theory of the production, distribution and utilisation of electrical energy, and in the theory of electrical measuring instruments.

(7) THEORY OF STRUCTURES AND STRENGTH OF MATERIALS.—The elementary theory of elasticity as illustrated in such problems as the bending of straight beams, torsion of shafts, struts, and stress in thin cylinders under pressure. Composition and properties of materials of construction. Testing of materials.

Digitized by Google

(8) PERSONAL QUALITIES.—The degree to which the candidate possesses personal qualities which are of importance for the situation of engineer in the Post Office will be judged, and marks awarded for those qualities.

It is understood that the new open competition referred to in the circular will replace the limited competitive examination among university candidates for second-class engineerships, and that no further examinations are to be held under the old conditions.

The Postmaster-General has also stated that it has been decided to waive the Civil Service examination hitherto imposed before promotion to the class of assistant staff engineers, and that, under the altered conditions, there will be a direct line of promotion, without further Civil Service certificate, from the class of assistant engineer to that of executive engineer, and thence to the higher posts in the Engineering Department.

A perusal of the new syllabus testifies to the reasonable character of the examination; it is one requiring knowledge of a wide range of subjects, but the subjects are all of direct practical utility. In passing, it is curious to note that the allied subjects of telegraphy and telephony are not specifically mentioned in the syllabus, and one cannot help regretting this omission as one tending to favour unduly candidates from outside the service, by nullifying the value of an important qualification, on which many candidates from within the Post Office have spent much time and study.

Perhaps the view of those responsible was merely the merciful one that sufficient unto the day is the syllabus thereof; the rude awakening may come during the probationary period!

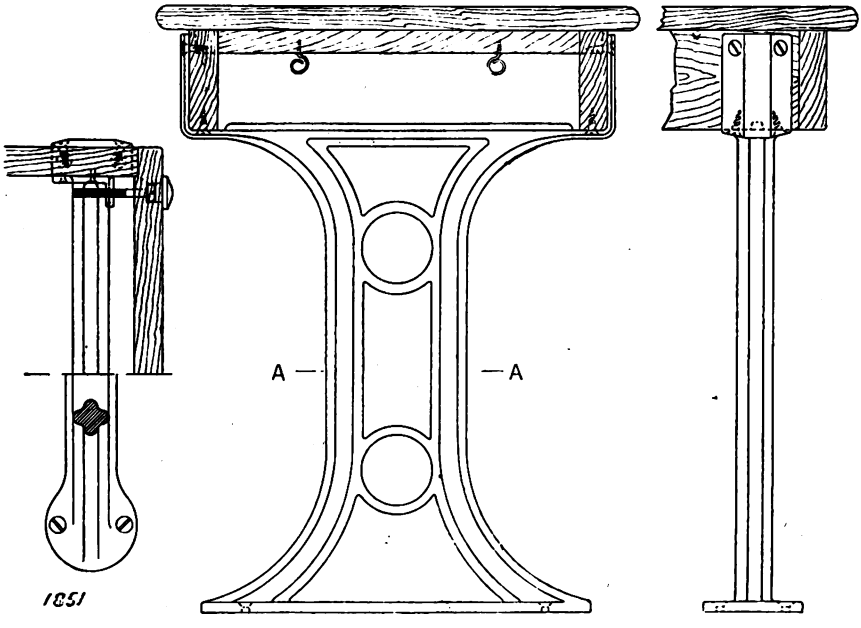
The Postmaster-General is to be congratulated upon the introduction of a wise measure of reform. The imposition of an educational test of a high standard at the outset of an engineer's career, where all the candidates are placed upon an equal footing, will undoubtedly result in attracting to the engineering service men of good technical ability, whilst the abolition of the series of examinations and interviews hitherto imposed at every step in an engineer's career will be very heartily welcomed. With an enormous volume of work to cope with, and a prospective development of the telephone services which will probably exceed the most liberal estimates, it is gratifying to know that the engineer has been relieved of what he had come to look upon as the examination incubus, and that the efficient performance of his varied and complicated duties will be the factor by which his fitness will be gauged when the time for promotion comes along.

Digitized by Google

NEW IDEAS.

A New Instrument Table.

Telegraph operators who have experienced the inconvenience of sitting with a table leg between their knees will welcome the new standard form of instrument table recently designed in the Engineer-



1.—New Telegraph Instrument Table. Detail of Cast Iron Standard.

in-Chief's office, and now introduced as the Office of Works' standard pattern.

This table is supported by central cast-iron standards instead of by the ordinary wooden legs front and back.

As the iron standards can be fitted where desired, or subsequently shifted to another position, it will in future be possible to give the claims of operators and apparatus more consideration than has hitherto been possible. Normally the legs will be placed about 8 ft. apart.

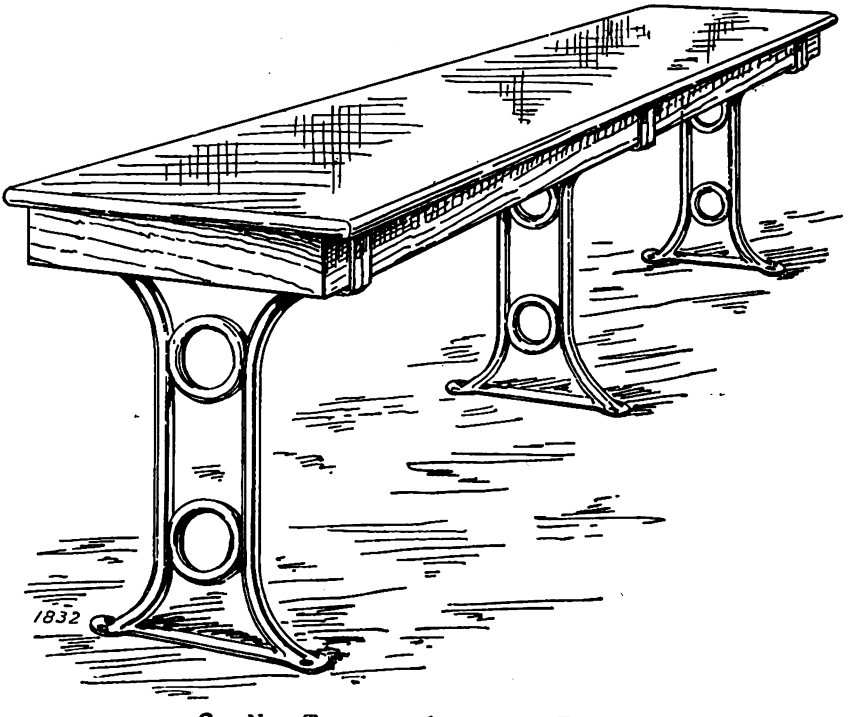
The table has been so designed as to enable it to be shortened by any ordinary workman who can use a saw, no morticing or tenoning being necessary. The rails and top are simply cut at the desired point, and the end-piece bolted in its new position.

Digitized by Google

Should a Wheatstone gear happen to come in the position occupied by a standard, the latter could be shifted to either side at the expense of a few minutes' work.

The appearance of the table can be gathered from the accompanying illustrations, the first of which shows the cast-iron standard in detail together with the attachment to table, while the second shows a complete table in perspective.

New features introduced with these tables are the abolition of



2.—New Telegraph Instrument Table.

"dust-boards" and the use of insulated screw-rings for carrying the wiring to the apparatus sets. The rings are fixed under the table-top, as shown in 1. They render wiring troughs in the body of the table unnecessary, and leave ample space for transmitter or receiver driving gears.

Similar tables will in future be used for Baudot receivers and keyboards, the abolition of the pedal driving gear in favour of a motor drive having rendered this practicable.

Baudot distributors are still weight-driven, and will continue to have special stands as heretofore.

Digitized by Google

COUNCIL NOTES.

A MEETING of the Council was held in London on July 17th and 18th, Mr. H. R. Kempe presiding.

The Chairman welcomed Mr. H. E. A. Wenman as the representative of the Assistant and Second Class Engineers (London) in the place of Mr. J. M. Crawford, who had resigned in consequence of his appointment as Assistant Electrical Engineer to the Commonwealth of Australia.

It was decided to invite the Postmaster-General to the opening meeting of the Metropolitan Centre on October 14th to present the medals awarded by the Council for papers read by members of the Institution.

It is hoped Mr. Samuel will be able to honour the Institution by his presence on this occasion.

In response to several requests the Council has decided to take steps with a view to arrangements being made for a special lecture on a subject of general interest to be delivered in each of the centres during the coming winter. It is hoped that an announcement will be made in time for the local committees to include the fixture in their programmes.

Major W. A. J. O'Meara's paper on "Multiple Telegraphs" and Mr. A. J. Stubbs' paper on "Protection from Fire" will, it is hoped, be in the hands of the members in the course of a few days.

In view of the conspicuous services rendered to the Institution by Mr. J. M. Crawford, the Council unanimously decided to add his name to the list of honorary members, and it is believed that the whole membership will heartily endorse the action of the Council in this matter.

Local secretaries are reminded that a copy of the programme of their forthcoming meetings should be sent to the Secretary as early as possible in order that the "Display Card" may be issued without unnecessary delay.

TELEPHONE DISTRIBUTION.

To the Editor, THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

DEAR SIR,—As an outsider I feel that it is rather presumptuous on my part to write on this matter at all, but as they do say, "Something may be learnt from even a fool," I am encouraged to give my humble views for what they are worth, in the hope that the importance of the subject will lead others, better able than I, to give their views on these new problems.

I feel sure, now that the Telephones have passed into the hands of the

Digitized by Google

State, that important developments in the growth of the Service will take place. In fact, if we look at the number of telephones per head of population, as compared with what obtains in other countries, it will be seen we are a long way behind. Let us therefore wisely prepare, and get our house in order, ready for the increases that *must* come.

I do not know of any more important point awaiting consideration than that of distribution, or the best way to reach our subscribers. In fact, we must prepare to reach almost every dwelling with our lines.

The humble suggestion I have to offer concerns the smaller towns, where, for some time at least, it will be cheaper to have overhead distribution from the underground cables.

It was thought in the earlier days that the best system of distribution poles was to have a few very tall poles in order to supply a large area, but I think this has been found in many cases to be a mistake, and we would do much better by erecting a large number of smaller D.Ps. supplying smaller areas. In fact, I would suggest that we put a small D.P. in every place where subscribers will be likely to come on.

Some of the advantages are:

(1) Wayleaves can be more easily obtained for small poles than for large ones.

(2) In case of a removal, the upset and cost is not so great as in the case of a large D.P.

(3) In case of storm, fire or lightning damage, the interruption would be less with the smaller D.Ps.

(4) A wireman or faultsman, going aloft on a congested D.P. where there are a large number of connections, stands a chance to break more of these on a large than on a small D.P.

(5) The greater number of small D.Ps. would shorten the spans of wires to subscribers' premises, and so do away with some of the troubles we get from vibration, which is a source of annoyance to subscribers.

I advocate overhead distribution as much as possible for its cheapness and being more get-at-able, for it must be remembered that in telephony, unlike telegraphy, we have to put up and take down our lines very often to suit the movements of subscribers who are continually changing position, and to meet these movements on a purely underground system might be a very costly matter in small towns.

It will also be plain to all that the public want as cheap a telephone service as they possibly can get consistent with efficiency.

These are the only points I have at present to suggest, but perhaps others with much more experience will step in and give their views, so that we may be found ready and with our loins (lines) girded, when called upon to meet the extra load *which is sure to come.*

Yours respectfully,

G. GILLMORE,

District Manager.

Isle of Man.

Digitized by Google

NEW BOOKS.

'Handbook on Standard Telephone Construction Methods,' by Frank B. Hall, Newton Falls, Ohio, U.S.A. (London Agents: S. Rentell and Co. Price 17s.)

The book is an epitome of American standard construction methods, produced in the form of specifications, which are divided up in a logical manner into various sections, dealing with exchange aërial construction, exchange underground construction, toll-line construction and sub-station wiring, with added sections for material specifications, material catalogue, drawings of standard items, and 214 pages of full-page figures showing standard methods. It is printed on good tough quality bond paper, pocket size, and arranged on the loose-leaf principle. Handbooks arranged in this style have been issued for private use by some of the large American telephone companies, but this is understood to be the first of the kind which has been offered to the general public. Paper, printing, drawings and general arrangement leave nothing to be desired, and the production is a very creditable one. Generally speaking the book covers the same ground as the Department's Instructions T.I. 13 and 14, with, however, special amplification of the methods used for jointing, underground, aërial, and block-wiring construction. Differences in the details of practice would lessen the value of the work to the Post Office Engineers, but as a complete record of standard methods on right principles the book has a very decided value.

POST OFFICE ENGINEERING DEPARTMENT.

STAFF CHANGES.

PROMOTIONS.

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept.	Turner, Capt. and Brevet-Major E. V.	Suptg. Engr., Irel'd.	—
,,	Elliott, J. R. M.	Suptg. Engr. (P.)	S.C.&T., '85; Relay Clk., '91; Engr., 2nd Cl., '96; Engr., 1st Cl., '01; Tech. Officer, 2nd Cl., '03; Asst. Suptg. Engr., '09.

Digitized by Google

PROMOTIONS—*continued.*

Office.	Name.	Appointment.	Previous Service.
Eng'g. Dept.	Hardie, J. .	Asst. Suptg. Engr. (P.)	Tel., '85; Jr. Clk., 2nd Cl., '91; Jr. Clk., 1st Cl., '92; Engr., 2nd Cl., '96; Engr., 1st Cl., '00; Exec. Engr., '11.
,,	Stubbs, W. J. .	Exec. Engr. (P.)	Tel., Preston, '88; Jr. Clk., Eng'g Dept., '96; Sub. Engr., '96; Engr., 2nd Cl., '99; 1st Cl., '06; Asst. Eng., '11
,,	Rolfe, W. J. .	,, (P.)	Tel., C.T.O., '83; Sub. Engr., '98; Eng., 2nd Cl., '01; Asst. Engr., '11.
,,	Billingham, G. W.	,, (P.)	S. C. & T., Birmingham, '84; Jr. Clk., '96; Sub. Engr., 98; Engr., 2nd Cl., '01; Asst. Eng., '11.
,,	Bowen, J. H. .	Clk., 1st Cl. (P.)	S. C. & T., Cardiff, '86; Jr. Clk., '98; Senr. Clk., '04.
,,	Larner, E. T. .	Clk., 2nd Cl. (L.)	Tel., C.T.O., '84; Jr. Clk., '00.
,,	Morris, G. L. .	,, (P.)	S. C. & T., Dublin, '88; Jr. Clk., '00.
,,	Miller, W. . .	,, (P.)	S. C. & T., Staines, '93; Bristol, '98; Jr. Clk., '00.
,,			

TRANSFERS.

Name.	Former.		Present.		Date from which to take effect.
	Rank.	District.	Rank.	District.	
Smith, D. McE.	Asst. Engr.	Met. Central	Asst. Engr.	Eastern	22 : 7 : 12
Dunsheath, P.	,,	Eastern	,,	E. in C. O.	1 : 8 : 12
Osborn, W. M.	Engr. 2nd Class	Testing Branch	Engr. 2nd Class	Met. Central	8 : 7 : 12
Roberts, A. E.	Ditto	Met. Central	Ditto	Testing Branch	8 : 7 : 12
Ward, E. .	3rd Class Clerk	North Eastern	3rd Class Clerk	North Western	3 : 6 : 12
Davey, C. T. .	Ditto	Met. Central	Ditto	Met. Power	5 : 6 : 12
Swift, J. E. .	,,	Eastern	,,	North Eastern	15 : 7 : 12
Owen, W. G.	,,	Met. Power	,,	Met. South	2 : 9 : 12
Riley, R. .	,,	Met. South	,,	Met. Power	2 : 9 : 12

COMMUNICATIONS.

All Remittances and Agents' Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

Editorial Communications and Correspondence should be addressed to Mr. D. H. KENNEDY, Norbiggin, 26, Oakley Avenue, Ealing, W. (Telephone, Ealing 1000.

Digitized by Google

Deposited at M. I.T.
HARVARD UNIVERSITY

THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL

THE INSTITUTION OF POST OFFICE ELECTRICAL ENGINEERS

VOL. 5 PART 4 JAN: 1913

Digitized by Google

ADVERTISEMENT INDEX

ESTABLISHED 1879.

THE

LONDON ELECTRIC WIRE COMPANY AND SMITHS, LTD.

Telegrams: "Electric, London." Telephone: No. 3105 London Wall.

Playhouse Yard, Golden Lane, London, E.C.

MANUFACTURERS OF

Every Description of Cables & Wires for Electrical Purposes.

Cotton-Covered & Braided Wires, Strips & Cables.
Silk-Covered Wires for Electrical Instruments.
Enamel Insulated Wires.
Multiple Cables for Telephones, &c.
Flexible Cords of all descriptions for Incandescent Lamps, &c.
Dynamo Brushes.
"Platinoid," "Eureka," AND OTHER **High Resistance Wires.**

Antwerp Telephone & Electrical Works,
ANTWERP.

Manufacturers of

TELEPHONIC APPARATUS

OF EVERY DESCRIPTION.

Wall Sets
Table Sets
Switchboards
Standard and Multiple
Domestic Sets

Bells
Receivers
Transmitters
All Accessories

Sole Agents for the United Kingdom—

W. F. DENNIS & CO.,

49, QUEEN VICTORIA STREET,
LONDON.

Stores: MILLWALL DOCKS, E.

Telegrams: "FREDENNIS, LONDON." Telephone: BANK 343.

Digitized by Google

Digitized by Google

Digitized by Google

THE
Post Office Electrical Engineers' Journal

THE COPENHAGEN TELEPHONE AUTOMATIC AID-SYSTEM.

By P. V. CHRISTENSEN,
Engineer, Copenhagen Telephone Company.

WHEN the number of telephone subscribers in a city becomes too great to be included in a single multiple switch-board, the work of manual operating grows so rapidly that considerable economical and technical difficulties arise. In Copenhagen, with its 550,000 inhabitants and about 40,000 telephones, the entire telephone plant has been rebuilt in the course of latter years. The choice of plant and working system is based on an exhaustive study of telephone operating, in regard to which a detailed description is given in an article under the heading "Telephone Service in Large Cities," printed in the POST OFFICE ELECTRICAL ENGINEERS' JOURNAL, 1910–11, a reprint of which may be had on application to the Copenhagen Telephone Company, Limited.

The present article refers to one of the special technical devices, the automatic aid-system, invented by Director Fr. Johannsen, on which patents, belonging to the Copenhagen Telephone Company, have been filed.

The aid-system, which can be used not only in new but also in old centrals of the double-cord system—magneto as well as common battery—is intended to lighten the burden of the operators in busy moments. The aid-system requires only slight alterations in the switch-boards proper. Three of the answering cords in each operator's position are connected with automatic selectors and in this way changed into "transfer cords." When the operator uses such a cord in attending to a call, she will transfer the call to a

Digitized by Google

disengaged colleague, the automatic device moving along till it reaches a wire from a disengaged operator within the same group of twenty operators to which the first operator belongs. Even in extremely busy moments, the probability of finding all twenty operators engaged is very slight, and therefore the transferred subscriber will quickly get an answer. On the position to which the automatic selector connects the subscriber, a lamp is lit opposite a call cord ("receiving cord"), of which there are four at every position. The operating of the transferred call is the same as in operating the single-cord system. After the conversation is finished, the clearing-out signal appears.

The technical description is annexed below.

1 shows a position in the new Copenhagen main exchange.

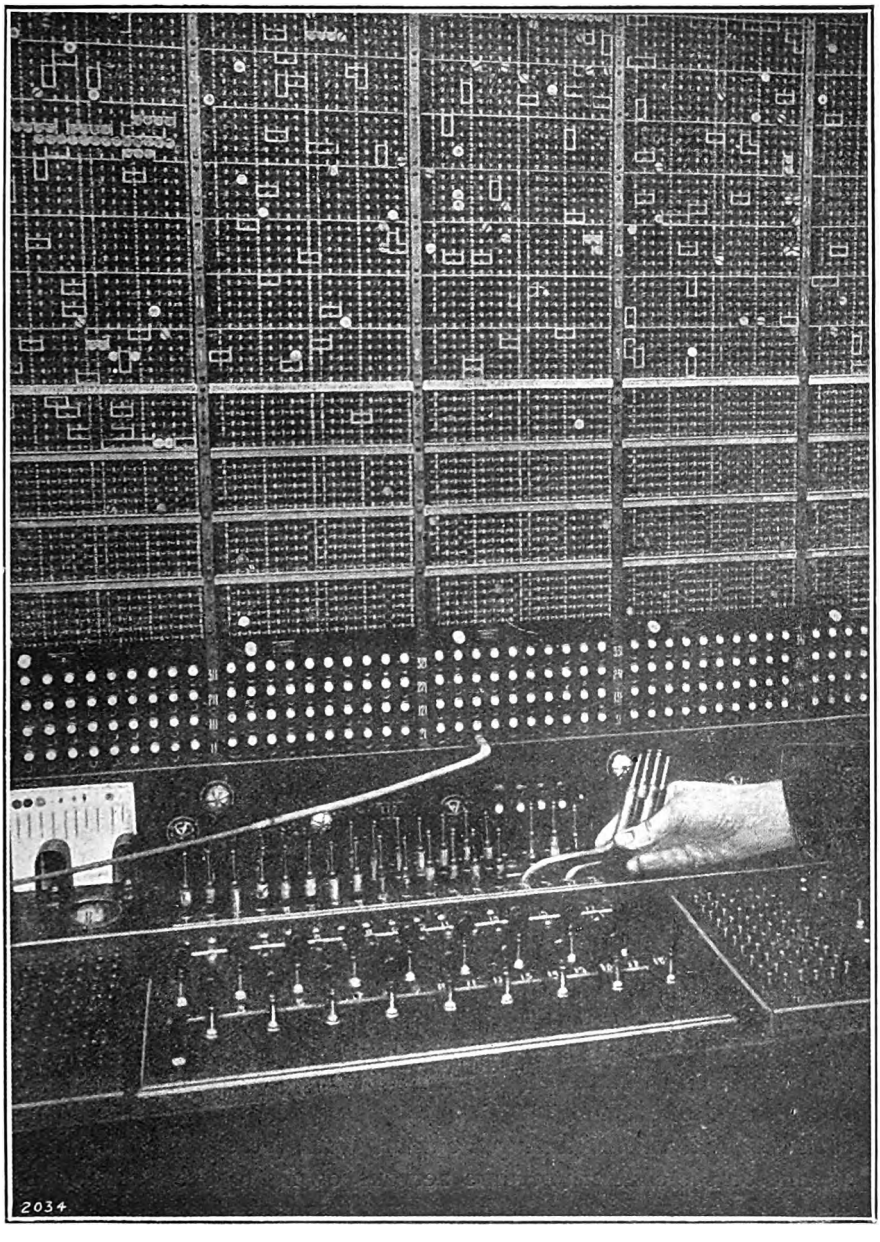
As a rule the operating takes place by means of the usual pairs of cords. Only when the operator and her neighbours are very busy the aid-system is used. In the aid-system there are essentially the same advantages as in the so-called distribution system, only with the exception that the dumb operators are rendered superfluous, their function being partly substituted by the A operators and partly (in the selection of a disengaged operator) by the automatic selector. Thus the operator can, at her own option, act as service operator in a double-cord multiple system or as dumb operator in a distribution system.

This system may also be compared with the so-called overflow system, only with the difference that the operator here does not need signals to inform her that the ancillary operator's positions are disengaged or engaged. The ancillary positions are rendered superfluous, since the transferred calls, as we have already said, are transferred, not to special ancillary switch-boards, but to regular service operators in the same group. The signals are superfluous, because the disengaged position is found automatically.

The effect of our system most resembles that of the American ancillary jacks, but is superior to this, because the operator is not disturbed by the many lamps, which she cannot and shall not answer. We have with much advantage replaced ancillary jacks on toll recording positions, in information office, etc., by automatic selectors acting in the same manner as in the aid-system.

Against the aid-system it has been objected that the A operator cannot see from what line a toll call originates, but by asking the subscriber for the number of his line it is very easy to prove this through the multiple. This would suit the well-known demand from subscribers with many extension stations (hotels, big stores, etc.), that toll calls should be ordered only by the operator at the extension board.

Digitized by Google



I.—Keyboard showing "Aid" Plugs and Cords.

Digitized by Google

Advantages of the Aid-System.

(1) (*a*) In an over-worked central there is so much labour saved that the operators are no longer over-exerted. Furthermore, the subscribers are much better served.

(*b*) In a well-organised central with normal waiting-time, it is possible either to save the expense of several operators or to allot a larger number of subscribers to each operator.

(2) Outside the busy hours, it is possible to a greater degree than otherwise to let some positions stand unused, since the neighbouring positions, when they are over-loaded, can make use of the aid-system —not only their own transfer cords, but also those belonging to the neighbouring positions. Besides the daily economy, this is of great significance in the summer, which is not so busy as the other seasons of the year, for by the use of the aid-system it is then possible without inconvenience to give the operators a summer vacation to a greater extent than otherwise.

(3) It is possible to economise the expenses of the plant, since each position can be adapted for many more subscribers than would be possible without this system.

(4) A further economy in building new centrals can be attained by being able *to omit the intermediate field*, for, when the aid-system is used, it is less essential if one position is somewhat busier than another.

(5) Finally, by installing the aid-system in an old central already in use, it is possible to *extend the period of its usefulness by several years*, which has, in fact, been done in some of the Copenhagen centrals, and which will be of very great economic importance in cities where it is difficult to decide to adopt a new system.

Relation to the Operators.

If it is asked what is the attitute of the operators in relation to the fact that, owing to the adoption of the aid-system, they have more work, it is found that the answer always is that they are very much satisfied with this arrangement. Since they are forbidden to talk to each other, as is the case in all modern centrals, they have been very much bored during the hours when there was not much to do, and on the contrary became nervous, owing to over-exertion, in the busy hours. During the busy hours it is now a comfort to have the aid-system to fall back on. They work less nervously and are less rushed, and therefore get more done, while the demoralising *ennui* of the dull hours is lessened by an evener distribution of the work. Experience has proved that the telephone operators in

Digitized by Google

Copenhagen consider the aid-system a relief, notwithstanding the fact that their average number of calls per hour has been increased.

Besides the direct benefit, the aid-system is important on account of the opportunity it gives the superintending officers to economise in the expenses for operators and to show more justice in distribution of the work, by giving a busy position less and an idle one more calls. If an operator tries to shirk during busy hours, the transferred calls will automatically find their way to her position. No abuse of the system by lazy operators, for instance, by blockading their positions, has been observed. This would at once be noticed by their neighbours or by the supervisors.

Rules for Use.

The aid-system must be used according to certain simple rules, which are essentially restricted to the following:

(*a*) A call that is to be transferred must be transferred at once. This rule is not difficult to impress on the operator. First when she can see that there will be too long a wait, she transfers the *next* call. We express the rule as follows: The transferring does not take place until both the operator in question and her two neighbours are engaged and one lamp is lit previous to the one whose call is to be transferred.

(*b*) A call that has been transferred from another board shall be given preference, even if the operator, in order to answer it, is obliged to transfer one of her own calls.

By following these rules, which in practice have soon been found to be successful, the aid-system will cover 10 per cent. of the calls during busy hours.

There is one little disadvantage, which, however, may almost be called an advantage instead, namely, that the inspectors in charge have more trouble in distributing the work, as it is possible and desirable to arrange the service at the switch-boards more carefully than heretofore. This, however, only serves to encourage an intelligent and dutiful inspection.

Trials with the Aid-System.

Exhaustive trials, for the purpose of investigating the functioning and economy of the aid-system, were made in a central in Copenhagen called "Öbro," where the apparatus was furnished by the Western Electric Co., and having fifteen A positions. The working of the central had about 90 per cent. trunking. At the beginning of these trials in the spring of 1909, fourteen of these positions had 160 engaged subscriber jacks each. As a result of the introduction of

Digitized by Google

the aid-system, it was possible in the course of the year to assign 220 jacks to each position instead of 160, thus reducing the number of positions in use from fourteen to ten. Notwithstanding the increased traffic at each position, the waiting time for the subscribers was shorter than previously when the traffic was not so intense. Besides the considerable annual economy in running expenses, there was also a great saving in the cost of the plant, for before the aid-system was introduced, it was considered necessary to enlarge the central, since there was only one idle position with 160 jacks. After the introduction of the aid-system, there were five idle positions, with 220 subscriber-jacks each, giving an opportunity to increase the number of subscribers by 1100. Thus the planned enlargement of the central could be postponed for several years.

To be honest, the entire economy which was attained was not all due to the aid-system directly, but also indirectly to the careful investigation of all the working conditions of the central which was caused by the introduction of the aid-system.

With respect to the indirect economy, it is noticed that, under ordinary circumstances, when an attempt is made to improve the service, the operators frequently consider it to be intended to press more work out of them, but this has not been the case with the introduction of the aid-system. The operators at once intuitively feel that it is a very practical and agreeable arrangement, which does away with all anxiety and nervousness in the busiest moments.

Detailed Report of the Trials.

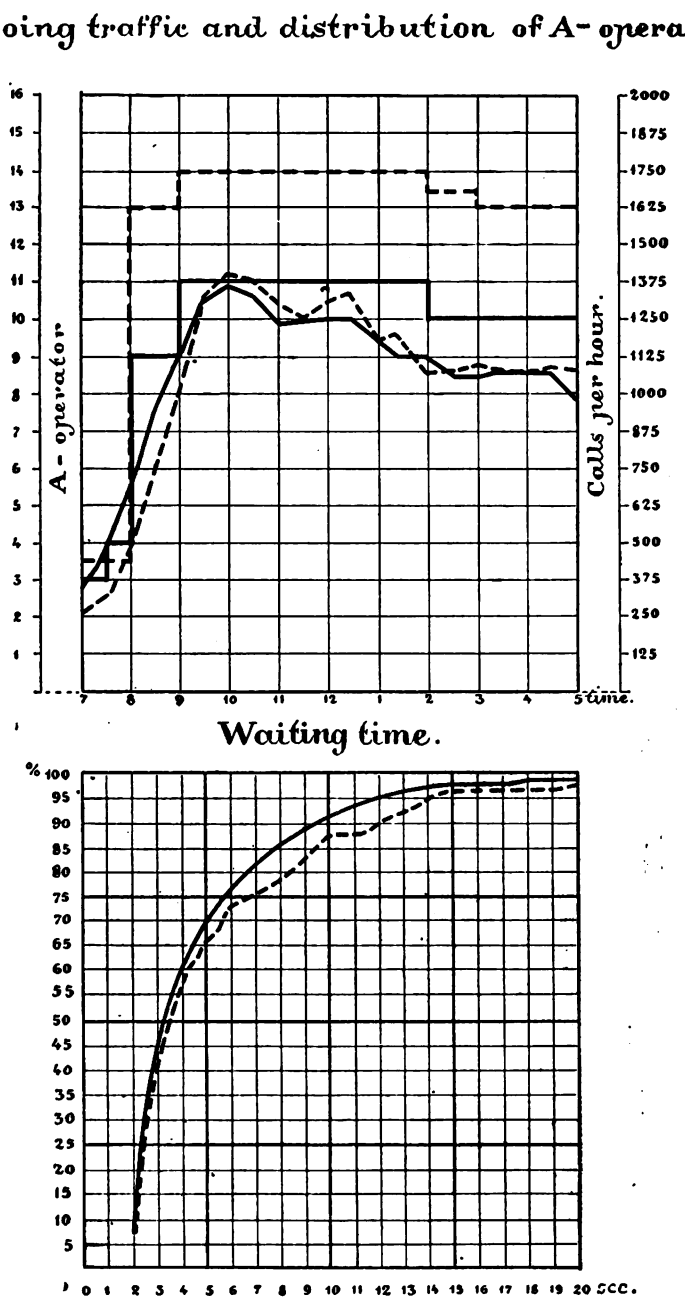
The results will be seen in the diagram, 2, which shows conditions before and after the introduction of the aid-system in April and October, 1909, respectively.

The figure shows that the traffic was about the same in April and October. Nevertheless the number of operators was reduced at all hours of the day, and still the service was improved, as also will be seen by 2, which shows how long the subscribers had to wait for a reply to their calls, both before and after the introduction of the aid-system.

The economy attained at "Öbro" is greater than shown by the diagram, since in the summer there has been a great saving of service hours. For a long period during the summer of 1909, only every second A position was in use, and in the transition from and to busy hours, the number of operators was evenly changed by adding or removing one operator at a time.

The whole economy of service attained at "Öbro" at the A boards amounted to about 30 per cent. If we deduct one third of

Digitized by Google



2.—Tests made at "Obro" Central Exchange. - - - - Before Aid-system in Use. ——— Aid-system in Use.

Digitized by Google

this as due to better management and training and a better equipment of the central with junction-lines, there will remain a saving of about 20 per cent. due to the aid-system (compare the control check given by 3). In connection herewith it may be remarked that the aid-system at the "Öbro" central has not had an opportunity to work under the most favourable conditions, the number of A operators having been too small. During the time of the trials this number was reduced from fourteen to seven in the dullest part of the summer, and increased again to eleven in the most busy hours of the day later on when the number of subscribers as well as the traffic in general became greater. While disengaged positions, as a rule, were blockaded for the receiving of transferred calls, it is understood that the selector of a transferred subscriber has only had an opportunity of hunting for a disengaged operator at from six to ten positions, while the system will be of still better effect if the automatic selector has an opportunity of hunting over up to twenty positions.

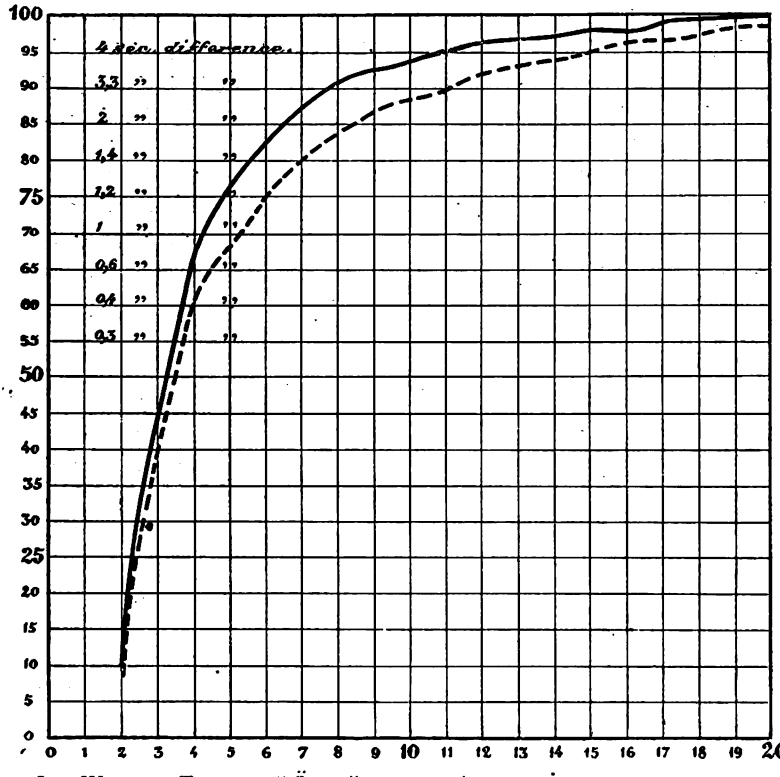
The trials at "Öbro" were made in easy time, in order to be sure to obtain reliable control-results in concentrating the subscribers. It was then found that the service was by no means made poorer by this concentration which took place after the introduction of the aid-system, one position being emptied at a time, with about one week's interval. During the trials repeated control-calls were given from the main distributing frame, and the a (*alfa*) * of the operators was controlled by means of an automatic a-clock, which was read off each hour for each switch-board. Every a-clock started of its own accord when one of the listening-keys of the switch-board was opened, and stopped as soon as the listening-key was closed. To the a indicated by the clock a certain percentage had to be added for work done in plugging and unplugging, which was calculated once for all and proved to be less for a large a than for a small a, since a large proportion of this work in busy hours is done at the same time that listening-keys stand open.

The determination of a per hour and position was of importance not only in order to see if the concentration was carried too far, but also to decide if eventual complaints from any of the operators as to being worked harder than others were well founded. The use of a-clocks gives a general idea whether the respective operators do too little work or not. While a is almost identical for all positions during the busy hours, when transferred calls come into disengaged operators, there will naturally be some difference in the a of the respective operators during duller hours, when the transferring only takes place in a smaller degree. It is always a bad sign when the

* a is defined as a pure number, which denotes the fraction of the time of the operator during which she is engaged in actual service. Thus $1-a$ denotes the fraction of her time during which she is disengaged.

Digitized by Google

a of an operator is essentially lower than that of her two neighbours. It might be added that the aid-system should tend to lessen the difference between busy and dull hours. Tests have, however, proved that it is not economical to go too far in equalising. The centralisation should take place to such a degree that the operators in the most busy forenoon hours, notwithstanding the presence of



3.—Waiting Time on "Öbro." ——— Aid-system was in use. - - - - Aid-system not in use.

the full number of operators, will be somewhat harder worked than the average for the whole day.

In daily work the a-clocks are of great importance for all changes in the number of operators. By the aid of the clocks it is easy to see when it is advisable to decrease the number of operator-hours, and how long to postpone the increase in the number of operators.

During the tests in "Öbro" there were made, besides the reading off of the a-clocks, frequent counts of different kinds: the main ampéremeter of the central was read off every half hour, after which there were drawn current-curves, which provided a good

Digitized by Google

means of comparison between the amount of service during different days and weeks.

Among the many tests which were made in "Öbro" may be mentioned that, for two successive weeks, with nearly identical working, about 2000 control calls were given from the main distributing frame. During the first week the aid-system was used, but not in the second. The accompanying drawing, 3, shows how the absence of the aid-system augmented the waiting time for the subscribers. During the first week we had about 5 per cent. of waiting times above eleven seconds, against 10 per cent. without the aid-system. This difference from 10 to 5 per cent., if it had to be reached by increasing the number of operators instead of using the aid-system, should, according to our calculations,* equal an increase of about 20 per cent. in number of operators. Besides this more theoretical calculation, a practical proof of the advantages of the system was afforded, as it was very difficult to meet the impatience of the operators during the last week. They demanded either the aid-system reopened or more operators to help to do the work.

Technical Description of the Aid-System.

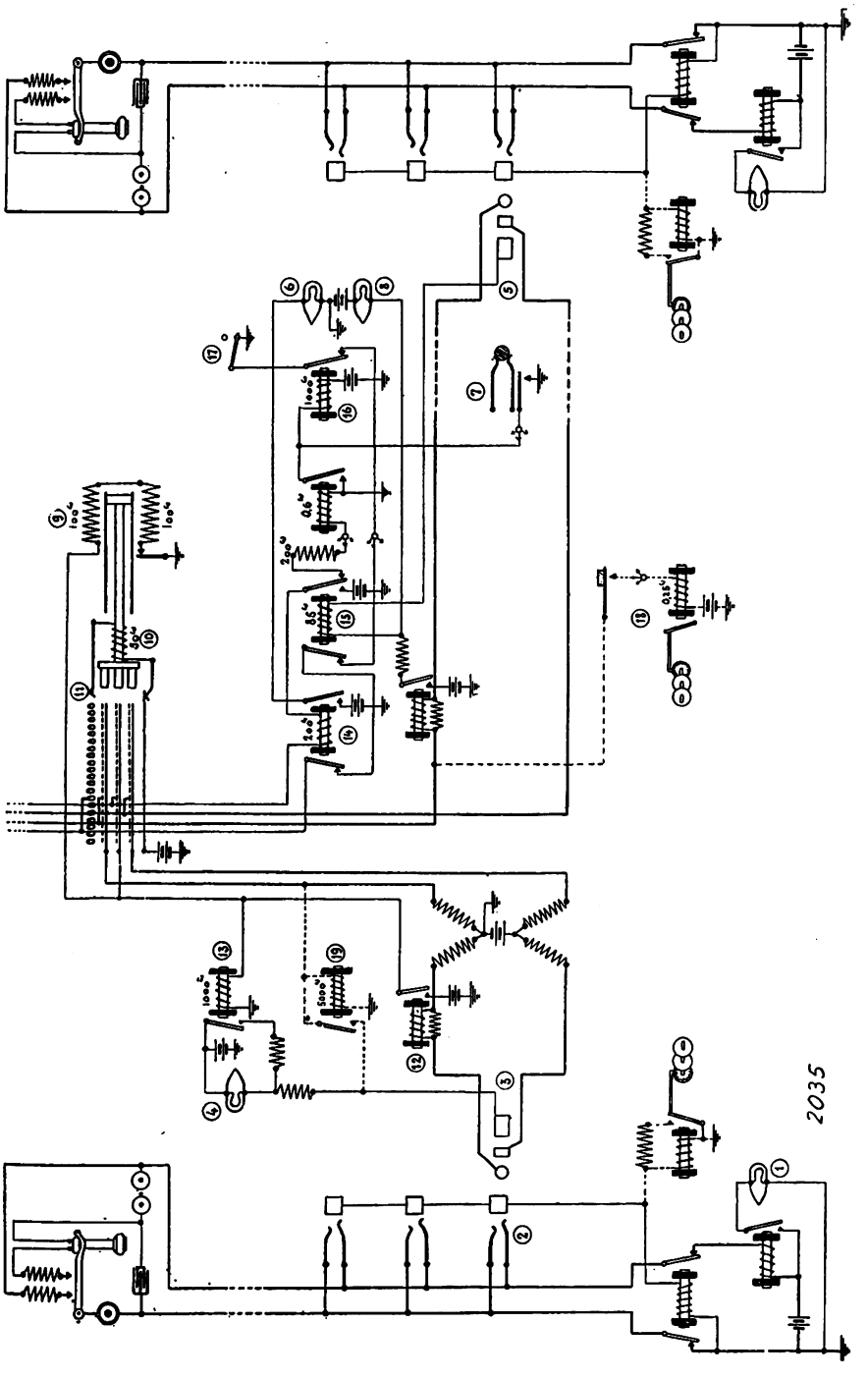
As will be seen from 1, there are at every position three transfer cords with appertaining three red lamps and four receiving cords, to which belong four white lamps. (The last-named cords are seen grasped with the hand.) Besides there belong to each receiving cord a listening-key and a green lamp to control the called subscriber. Since both key and lamp function are used exactly the same as the corresponding key and lamp of the cord-pairs, they will not be given further mention in this description.

Each of the transfer cords is connected with the contact rail in an automatic selector. For 20-operator positions there are thus 60 automatic selectors, divided into 4 groups of 15 selectors each. The contacts in the contact-multiples of the selectors are carried to the call cords. Since each selector-multiple has 20 contacts (*i. e.*: each selector has 20 contact-positions) the total number of multiple-contacts corresponds to $4 \times 20 = 80$ receiving cords, which are thus distributed over the same 20-operator positions.

In 4, which shows the aid-system installed in switch-boards of the Western Electric Co.'s make, 1 is a subscriber's lamp, 2 is a subscriber's jack, 3 is a transfer cord, and 4 is the appertaining red lamp. The call cord is denoted by 5, the accessory white lamp by 6, and finally the listening key and the green lamp by 7 and 8. In the centre of the diagram drawing there is a sketch of the automatic

* See tables for 5 per cent. and 10 per cent. operating, Post Office Electrical Engineers' Journal, January, 1911.

Digitized by Google



4.—Aid-system. Diagram of Circuits.

Digitized by Google

selector used in Copenhagen, which is described below. The selector is run or started by means of the magnet 9. The stopping on the disengaged contact is accomplished by the magnet 10 with the search-spring 11.

The system works as follows:

When 1 is lit, the plug 3 is inserted in the jack 2. When this is done the relays 12 and 13 attract their armatures and the magnet 9 is supplied with current, so that the selector is set in motion. The search-spring 11, which moves over a series of contacts, selects one of these which is in connection with the ground (the battery's positive pole), and here the selector stops, while the magnet 10 is supplied with current. The two speaking wires in the plug 3 are now passed through the repeating-coil and selector to the plug 5. While the relay 14 is working, the lamp 6 is lit beside the call cord: it is extinguished when the plug 5 is inserted in the multiple-jack. When the calling subscriber hangs up the receiver, the relay 12 will drop its armature and then the relay 14 again attracts its armature and lights the lamp 6; while this means clearing-out, the plug 5 is taken out of the jack, the relay 15 drops its armature, and the magnet 9 in the selector is cut off from the current, after which the selector returns. Then the relay 13 with the transfer cord drops its armature, and the red lamp 4 is lit, after which the plug 3 is withdrawn.

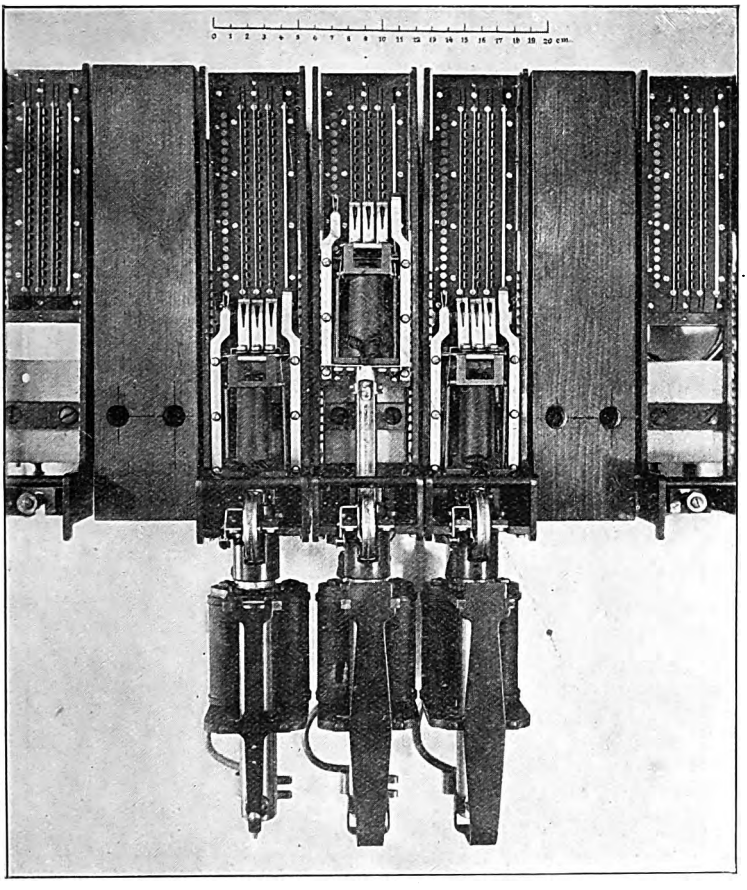
It was mentioned above that the selector is stopped by the magnet 10, while the search-spring 11 touches a contact in connection with the ground. This will be the case when the relays 14, 15 and 16 are without current. The relays 14 and 15, which belong to the call cord, will be without current when the receiving cord is not in use. The relay 16, which belongs to the operator's position, will be without current when all listening-keys 7 are in a position of rest. (In the listening-key 7 there is only shown the contact spring which causes the position to appear engaged during operation, but no springs for the speaking and ringing circuits.) Thus it will be seen that the condition for a transferred subscriber to come into connection with a certain receiving cord is, in the first place, that this cord is not engaged, and, in the second place, that the operator at the position to which it is connected is disengaged; *id est* that all listening keys in the position are at rest. When there is no operator at a position, it is "closed" by means of switch 17.

Counting Messages.

In Copenhagen there is no exact count kept of the messages, and therefore in the aid-system there is no provision made in this respect. There is, however, nothing to prevent the messages from being

Digitized by Google

counted in the usual manner, each receiving cord being furnished with a press-button, the same as with the other pairs of cords. In 4, the press-button on the receiving cord, and the position-counter 18 as well as the subscriber's message counter and 5000 ohms relay 19, belonging to the transfer cord, are indicated by dotted lines. The counting in this case takes place over one of the speaking



5.—Christensen's Electro-pneumatic Selector.

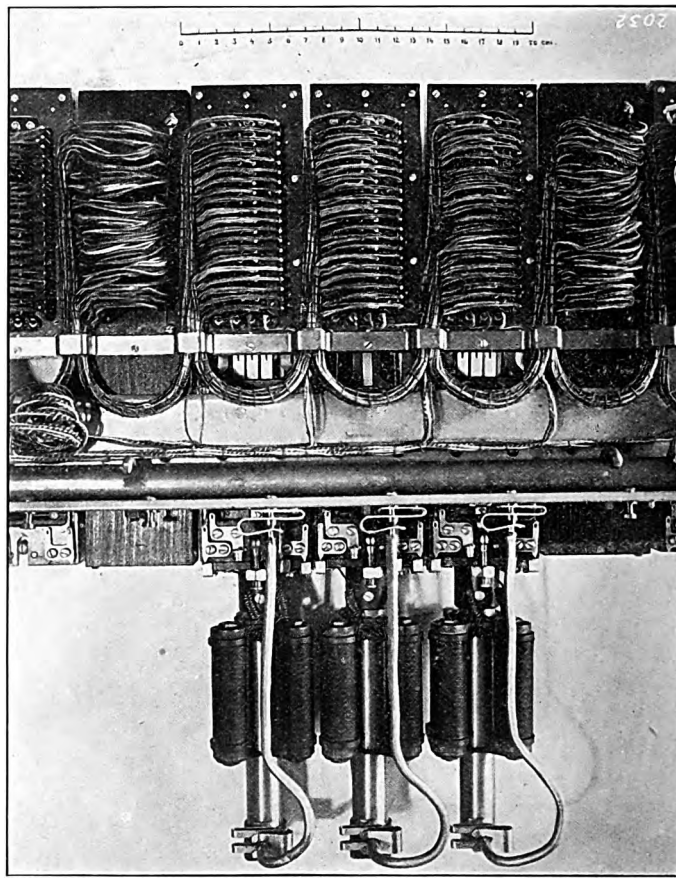
wires, which will not cause any inconvenience, since the counting is done after the conversation is finished.

Christensen's Electro-Pneumatic Selector.

This selector, which is used in all aid-systems in Copenhagen, has, in contrast to most other selectors, a rectilinear movement. The motive power is compressed air of one atmosphere pressure per

Digitized by Google

square centimetre. The contact-springs do not touch the stationary contacts in passing forward, but when a disengaged contact is selected, the movable springs are pressed by the air-pressure against the stationary contacts. Of course there is an exception to this rule with respect to the search-spring, which with a roller runs



6.—Christensen's Electro-pneumatic Selector—Top View.

forward over the stationary contacts. The speed of movement is such that the 20 contacts are all searched in 0·6 second. Should, for the moment, all 20 contacts be engaged (which can seldom be the case), the selector goes back and forth until it finds a disengaged contact. 5 shows a few selectors seen from below. 6 is a top-view of the same. If a selector should get out of order, the running mechanism can very simply be exchanged in about 35 seconds. For producing the compressed air there is used a little motor-compressor

Digitized by Google

with an automatic starting device. The consumption of air is about 0·07 litres of atmospheric air per selector per minute.

The selector has also been extensively used in Copenhagen independent of the aid-system. The use of the selector in the order wire service, for instance, has made it possible for every A operator to use only one order wire key for every other exchange. When the key is pressed, the selector automatically connects the A operator with a disengaged B operator (see 'Electrotechnische Zeitschrift,' 1909, Nr. 42). Furthermore, the selectors are used for finding disengaged operators on recording positions in the toll line exchange, in the information office, and in the trouble office.

THE STATE TELEPHONE SERVICE.*

By A. M. J. OGILVIE, C.B.

BEFORE proceeding to the subject we are to discuss this evening, I should like to take this opportunity of thanking the Society for the honour you have done me in electing me as your President during this first year of the union of the two Telephone services, and of their combination into a uniform and general State system, and I can only say that I shall have the greatest pleasure in attending the meetings, as affording opportunities of knowing many colleagues in the various branches of the Telephone service, and in listening to the interesting papers and discussions on subjects with which one is to some extent familiar from one point of view, but which will be treated from different points of view and with the advantage of practical experience of many kinds.

The subject which has suggested itself as suitable to our present circumstances is the rather obvious one of the advantages and disadvantages of a State telephone service, both from the point of view of the public for whom the service is provided, and from the point of view of those engaged in providing it.

If, in dealing with the first part of the subject, it may be necessary to some extent, in contrasting the State management with commercial management, to refer to matters connected with the history of the National Telephone Company in this country and of the private and commercial telephone companies in the United States, I shall endeavour to keep entirely free from matters of current controversy, to treat the subject in as abstract and scientific a manner as possible, and to avoid any statements which may

* Presidential Address delivered at the inaugural meeting of the Telephone Society of London, October 7th, 1912.

Digitized by Google

arouse partisan feelings. We must also avoid personal questions. I know that any great change from known conditions to new conditions, such as you have all recently experienced, must produce a sense of disturbance, of uncertainty, and even of apprehension in the minds of many. That feeling will, however, as we hope, soon pass away as you become accustomed to the new conditions, but, in any case, I am sure we shall all agree that personal and individual questions can be better discussed at other times and by other methods. What we especially want to consider to-night is the effect of the change on our individual efficiency, and what are the aims and aspirations which we have to adopt in our work to secure the best results for the service.

Probably many of you have lately become familiar with a certain kind of newspaper criticism of our State telephone service. This we need not, I think, discuss at any great length to-night. Its impression is unpleasant on the minds of those engaged in the service, but we need hardly attach too much importance to it. To some extent it is probably due to the special circumstances of the moment. No doubt many subscribers expected that under a State system something like a telephone millennium would arise, forgetting that the incidental changes and disturbances which were inevitable in such a transfer would, by themselves, create a number of new and special difficulties in the service. Then, again, many people will undoubtedly suffer a good deal in their relations with a public telephone company or a railway company, and yet lose all patience and restraint if they have to deal with a Government Department. In the one case there is an underlying feeling that, after all, it may be said to them that they need not, unless they wish, become customers of a commercial company, even if the company is practically a monopolist; but they feel that a Government Service most provide for the wants of all, irrespective of commercial considerations, and that they themselves are the employers and masters of that public service. Further, the relation between the telephone service and its subscribers is a direct and personal one. A subscriber takes an active part in each call. Any difficulty or mistake affects him in a quite special and personal way. The delay, or even the loss or failure of a letter or telegram, would affect him quite differently.

A general result of this feeling has been to induce a belief in some persons that there was a sudden deterioration in the whole staff at the moment of the transfer. Many of the subscribers on the Company's Exchange believe that their service radically changed on the 1st of January, and the same thing occurred with many subscribers to Post Office Exchanges, although it is obvious that their service could not in any way be affected by the fact that the Company's system had been united with the Post Office. A writer

Digitized by Google

in the 'Daily Mail,' who described himself as a great American expert, solemnly declared, not long ago, that leading men in the telephone service and eminent scientists had explained to him that there had been a general loss of from 5 per cent. to 20 per cent. in the efficiency of the operating staff, solely as the result of the transfer of the staff from private to State employment.

Criticism of this kind directed against a State telephone service need not, I think, be taken too literally. Its real lesson to us is this—that the sense of grievance which a certain proportion of subscribers and all newspapers, have against telephone undertakings of all kinds and in all countries is likely now to find louder and more excited expression than hitherto in England, and that to meet it we shall have one and all to exercise the most unremitting patience. We must be attentive, and even sympathetic, to what appear to be the most angry and baseless complaints in order to discover the reasons for them, and we must never let our equilibrium be upset. Whether we are engaged in operating, in construction or maintenance, there is more than ever a necessity for complete efficiency in every detail of work, so that the inevitable cases of difficulty may be as few as possible. There is a fixed belief, or perhaps I might call it a superstition, in the minds of many persons that the staff of Government departments are a special class unlike other human beings, that they spend their time in the strenuous neglect of their duties, and that their chief pleasure is in assuming a haughty manner towards the outside world. Whether this belief or superstition had its origin in real conditions in the past I will not attempt to decide. Possibly it had, but of this I am sure, that it does not represent reality nowadays. Nevertheless we shall probably, for a good many years, have to struggle against it, and only then will it cease if the constant fitness of our work, and of the manner in which we do it, shows the belief to be baseless.

I will now turn to other and more weighty kinds of criticism. The last century, as we all know, was marked by enormous advances in the mechanical agencies of work, in the scientific knowledge which opens out new fields of industries, and in the invention of machinery to perform in a rapid and economical manner all the numerous processes of manufacture which previously depended upon the personal skill of individual craftsmen. The development of all these new ideas and new methods was undoubtedly made possible only by the initiative and the genius of individuals. This probably is the case with every great change, and with every great advance in the history of thought or of commerce or industry, and the wonderful success which attended the industrial movements of the last century undoubtedly created a great impression in favour of individualism. A school of writers and thinkers arose, who con-

Digitized by Google

trasted the great results which have been obtained in this way with the slow progress which had been made in previous centuries, and a firm belief grew that it was only by leaving the individual absolutely free and unfettered, by encouraging competition in every shape and form, and by reducing Governmental control to a minimum, that any real social or industrial progress would be possible. Probably a good many of you have read some of the works of Herbert Spencer, and you will find him a consistent upholder of this theory of individualism. Undoubtedly such thinkers can produce from the history of Government action and Government organisation in the past many arguments in favour of their case, and, if the circumstances of every age were the same as the circumstances of that from which they drew their arguments, probably their case would be incontrovertible. We must remember, however, that every age is not marked by great revolutionary changes, and that as conditions become better known and more settled, other forms of management and of organisation may become more suitable. The later history of the nineteenth century has shown that unrestricted and unchecked commercial enterprise may gradually produce evils, especially as that enterprise tends to become monopolistic, which require serious regulation both from the point of view of the consumer and from the point of view of those who are engaged in the work of production.

It is no doubt true that during the period of severe competition those who direct any industry are keenly alive to the wants of those whom it serves, and to the provision of this service at the cheapest possible rate. If there is free competition during a period of rapid development in the range and equipment of an industry, the pioneers may be, and often are, successfully ousted by competitors who start with the benefit of their experience and with improved appliances. In this way the public may have the cheapest service of a most efficient kind, but it must be remembered that the nation, as a whole, suffers a considerable loss from the sacrifice of the plant, and of the organisation which the pioneers have provided. The effect of free competition is, therefore, not all gain.

But this period of free competition in any industry tends to pass away. We see that competitors in manufacturing work find out that by combination they can secure a much bigger share of the profit than by severe competition. The individual firms and enterprises in each industry tend to combine, and in America we have seen a gradual formation of trusts or combinations among businesses designed to get rid of the difficulties and dangers of competition. The telephone business is essentially a business in which a movement of this kind tends to take place, and sooner or later such a business will become a monopoly. Even in the United States, where

Digitized by Google

competition has existed on the largest scale, and where the rewards of business enterprise are so great and immediate that the danger of defeat at the hands of a successful competitor is comparatively unimportant, we see a gradual movement for the combination of all telephone enterprise. You are all probably familiar with the present organisation of the American companies known as the Bell system, in which a single controlling company manages a federation of operating companies. These operating companies of the Bell system were, in the first instance, numbered by hundreds and thousands. A gradual process of union has gone on until now I believe there are only nine operating companies in this federation, and although technically these companies are distinct, they are practically one concern. Their separation has no element of competition in it, but is merely one for the convenient localisation of financial and business management. When the Edison telephone patents expired in 1904 in the United States the Bell companies were immediately faced by opposition from numerous independent companies all over the country. Of these companies many thousands have been formed, and the number to-day is very large, but it is evident that the time of free competition is coming to an end. Many of the independent companies have federated with the Bell system for the purpose of intercommunication between their own exchanges and exchanges in distant towns. Others separated under competitive conditions and with unduly low rates have failed financially and have disappeared. There is, besides, a growing feeling in the United States that for telephone purposes a system of separate enterprises leaves much to be desired. The essence of telephone service is to abolish time and distance in communicating between man and man, and the freer and more general that communication is, the better is the service. The ideal of a public telephone service is that every telephone throughout the country should be a channel of communication with every other telephone, and this ideal can only be attained when the whole of the telephone enterprises of the country are combined in one system.

It is also evident that unrestricted competition in telephone work has failed in another way. After the reaction from the unduly high rates of the original monopoly cheap rates were offered in competition which have proved commercially unsound. Such rates if continued result in disaster to the telephone undertaking and directly or indirectly in serious loss and inconvenience to the community. It is clear, therefore, that ultimately some system of public regulation of rates in the interests both of the telephone undertakings and of the community is necessary, and as soon as this is established we have an end of free competitive conditions. If a company undertakes to serve the community at certain rates, desiring to give

Digitized by Google

efficient service to the public at a moderate profit to the company, it is clear that that company must be protected by the community, and that the influence of competition must be greatly restricted, if it does not wholly disappear.

The upholders of the individualist theory have also pointed out that the desire to secure large profits is the best guarantee that those controlling any industry will give their best energy and their best thought to the service of the public, but as soon as an industry becomes a monopoly it is clear that the public cannot submit to the exactions which the managers of that industry can then make. Those of us who remember the time when telephone enterprise in this country and in the United States was originally protected by patent rights will remember how unprogressive was the service. The development was slow, and the rates of charge were the highest that the public would pay. The desire was to secure large profits on small capital expenditure rather than to earn larger profits by risking larger sums. Whereas the aim of a properly directed public undertaking should be to give the largest possible amount of service at the lowest rates which will yield a reasonable return, the aim of the old telephone companies was undoubtedly to make the highest possible profits by providing a minimum of service. It was the stress of competition which changed this condition, and which led to the organisation in this country of the National Telephone Company as a single and highly efficient service, and which has led in the United States to that extraordinary development in business and efficiency with which we are so familiar; but this condition is not a permanent one. If the National Telephone Company had been free from all restrictions and had been able to continue its business indefinitely, undoubtedly a rigid monopoly extending over the whole country would have been established, and it is almost certain that the efficiency developed during the years of stress would gradually have become relaxed as the necessity for further effort disappeared. In the United States we see that the telephone companies are recognising that public regulation of rates is a necessity, and a noteworthy feature of telephone business is the number of inquiries which are now going on to determine the necessary capital and annual cost of providing a telephone service. These being determined, the rates of profit to which the companies are entitled are also being determined and so public rates of charge are being fixed.

Undoubtedly at the present time the financial and technical management of these telephone companies has reached a very high degree of perfection, and it remains to be seen what the effect of regulation of profits will be. If the reward of high rates of profit is taken away from such enterprises, and at the same time the fear

Digitized by Google

of competition is considerably reduced, it is almost inevitable that the energy of work will be relaxed. The effort will be merely to maintain matters in a state of equilibrium. Plant which is serving its purpose will not be sacrificed in the hope that other more efficient plant will yield a higher rate of profit, and, although the change may come gradually, it seems almost inevitable that the influences affecting the service will be those which are always represented as the drawbacks of State or public enterprise. Nevertheless it is unimaginable that any country could allow a service which affects every individual in the community to fall into the hands of an unrestricted commercial company, and whatever the difficulties of public regulations or of public management, they must clearly be faced sooner or later.

I will now turn to another class of critics of State telephone service, namely, those who base their arguments on the actual results hitherto obtained by the telegraph and telephone services of the countries of Europe. Most of you know very well one of the ablest of these critics, Mr. Laws Webb, who was for some years associated with the New York Telephone Company, and more recently to some extent with the National Telephone Company. Not unnaturally, however, from his knowledge of the efficiency and success of those companies, Mr. Laws Webb sees many advantages in giving greater freedom and greater public assistance to such admirable enterprises. Another critic of the same way of thinking is Professor Meyer, of Chicago, who recently published two books against public or State enterprise in railways as well as telegraphs and telephones. The circumstances which led Professor Meyer to turn his attention to telegraphs and telephones were that the City Council of Chicago some years ago instituted an inquiry as to the best method of securing an efficient telephone service at reasonable rates. Although neither the Government nor the States nor cities of the United States have any direct legal control over such enterprises, the fact that a modern telephone service must lay its wires under the public streets made the Corporation of Chicago to some extent masters of the situation. An old-established company, managed with great enterprise and success, was in possession of the field, but its rates were high. A proposal was made to the Corporation that a competitive company should be formed which would undertake the service at greatly reduced rates and with improved equipment. The possibility of a municipal service was also considered, and the whole situation created a great deal of interest. Professor Meyer's two books, one on the British State telegraphs, and the other on the history of telephones in Great Britain, were arguments directed against public ownership, the case for which is certainly much weaker in the United States than it is in this country.

Digitized by Google

So far as I know, the water supply of the cities is the only public or general utility service which is performed by corporations or by any public body in the United States, and the results of public control in this instance have been unfortunate for the health of American cities. A water supply above suspicion provided by a local authority, such as most of our English towns and cities enjoy, is a thing almost unknown in the United States.

The arguments used by Mr. Webb and Professor Meyer follow pretty much the same lines, and I will try to state and meet some of the most important.

Upon his study of the British State telegraph system Professor Meyer founds three principal charges. The first is that the Government of 1868 plunged recklessly into the business without realising the heavy expenditure which would have to be incurred, and with too sanguine expectations of the revenue to be earned. This disregard of exact financial calculations has, he says, been always a feature of the telegraph service. Parliament has constantly interfered to put pressure on the Post Office to extend its system in unprofitable directions, and in 1885 it compelled the Post Office to adopt the present unremunerative sixpenny rate, in spite of the practical certainty that the business would in future have to be conducted at a loss. There are many disadvantages of such a condition. The management of a losing business must always be very cautious and conservative, and opposed to any change that will lead to further expenditure and further risk of loss. Mr. Webb uses similar arguments as regards the telephone services in most European countries, and he also points out that the absence of exact accounting methods, by which expenditure can be analysed and its comparative results clearly ascertained, has made good management of the State telephone systems very difficult. Moreover, in most countries the capital required for the business has had to be provided as part of the ordinary annual expenditure, and therefore the financial authorities have always opposed the outlay required for new developments and new equipment, so long as the existing equipment could be made to serve its purpose and earn a revenue.

Undoubtedly the risk of any system of expenditure which is at one time too reckless and at another time too cautious is one of the great dangers which a State telephone enterprise has to fear. Parliament has, however, now before it the results of its own action as regards the telegraphs, and, although I do not suppose that that action is likely to be reversed, there is no doubt that greater prudence will be exercised in the regulation of telephone rates. Probably a certain section of the commercial public will demand a cheap flat rate which sooner or later would involve a heavy loss, but

Digitized by Google

on the whole it may be said that public opinion has come to realise that the best method of finance is to make the revenue of each service meet the expenditure, and to take care by a good system of accounts that the results of expenditure as affecting the service can be clearly realised, so that when developments are necessary there may be neither undue haste in sacrificing the results of previous expenditure nor undue hesitation in accepting the advantages offered by new ideas and new inventions. It will be one of our most important duties so to organise the telephone service that the accounts of its working will enable the results of every department to be gauged with accuracy. Provided that Parliament is convinced of the necessity for all expenditure I do not think that there will be much force in the efforts to fix public rates which will clearly involve loss, and, if the objection to such a policy is recognised, then the demand of Parliament and the public for an extension of the service and for higher efficiency combined with economy, instead of being disastrous, will be beneficial. In this country, fortunately, Parliament has not confined the provision for the telephone service to the annual votes, but has granted large capital sums to provide for the extension of the service.

Both Professor Meyer and Mr. Webb point out that in countries where a telephonic monopoly has been held by the Government the development of telephones has been restricted in the interests of the telegraph service. That there has been restriction while the telephone service has been in the hands of private companies is of course obvious. On the other hand, when the telephone service becomes united with the telegraph service in the hands of the State, there is no longer any reason why the one service should be favoured at the expense of the other. In some countries for a little time after the union there may have been a wish to make the telegraph service fulfil its original purpose to an extent which has ignored the fact that the telephone system in many ways serves the same purpose with greater efficiency and economy. This tendency will, however, rapidly disappear after the fusion of the two services, and the varying requirements of the public will be met by whichever system offers the greatest advantage.

Another serious argument which Professor Meyer and Mr. Webb base on the history of the telegraph service in this country is that the constant and unreasonable interference by Parliament have made it impossible to secure efficiency or proper discipline among the staff. The best men, they say, cannot be promoted, and the inefficient cannot be punished. The voting power of the staff and their friends is sufficient to exact from Parliamentary candidates pledges to support excessive demands for the increase of wages and for the improvement of the other conditions of

Digitized by Google

service, without regard to the conditions of similar work outside the Government Service or to the effect on the public revenue.

I am aware that in dealing with these arguments I am treading on somewhat dangerous ground. There is no doubt that the influence of Parliament in dealing with the organisation of the staff as well as with the general financial management has caused considerable difficulty in the past, and that, if the results of that influence had been what Professor Meyer and Mr. Webb think they have been, and if this system were likely to be perpetuated, the most pessimistic views might be justified. I do not think, however, that it is necessary to take such views. We must remember that the conditions of employment in all industries have been the subject of much struggle and much discussion during recent years. Undoubtedly the effect of unrestricted commercialism of the last century was to create conditions which were unnecessarily unfavourable to the workers, and which in the long run reacted on the welfare of the entire community. There has been a steady movement to improve industrial conditions on all sides, and naturally Parliament has been anxious that the State, in its capacity as employer, should treat its employees with reasonableness and liberality. We must also remember that the organisation of State service is in a state of evolution. A considerable amount of experiment and discussion is necessary before its permanent conditions can be settled, but I do not see why we should not hope that when the organisation of public departments has been improved and the conditions of work made satisfactory, Parliament will gladly acquiesce in a system of management to secure both efficiency and economy.

To sum up, I think that it may be said that the arguments in favour of unrestricted commercial enterprise as against public or State enterprise are based on conditions which are temporary and are rapidly changing. No doubt new ideas are produced and must be made effective in the first instance by individual enterprise and energy, but, when the era of change has passed, what we require is the steady maintenance of a service of which the principles, aims and methods have been fully established. There is no reason why we should not adopt a form of management which offers the most advantages to the community at large. It may be said that those employed in such a service are deprived of the prospect of special and direct reward for personal exertion, and that, being more or less assured of employment, they do not care to improve their efficiency. There are, no doubt, tendencies of this kind at work in all State organisations, but I do not believe so badly of human nature as to think that such results are general or necessary. Whatever may be said about our telegraph service, there is no doubt that in its extension and its efficiency of working it compares

Digitized by Google

favourably with any other form of telegraph service. In the United States where the telegraphs are in the hands of two large private companies, what we find is keen competition for the business between great centres, duplicate offices where business is to be secured, and rapidity of transmission where the traffic will bear high rates. On the other hand, the telegraph service in America has never been extended to the more remote parts of the country. It did not even reach the suburbs of the great cities, and it was this neglect which left such an open field for telephonic development. The rates of charge are higher than in this country, and the service has never been adopted for domestic or social purposes nor even for the purposes of less important business as it has in this country. The vice-president of one of the great American telegraph companies said to me not long ago that if a telegram is received at a private house the impression created is that there has been a death in the family or some similar calamity. There is no doubt that the English telegraph service is relatively a service of more general efficiency, and that this result is due to a great extent to the efficiency of those who manage and work the service and provide its equipment. If we want another instance of Government work which compares favourably with the results of private enterprise we may turn to our own dockyards, where our battleships and cruisers can be built as well as, and as cheaply as, in private shipyards. Looking at human nature generally it is absurd to say that the hope of gain or reward is the only motive for great exertion or for faithful service. We know that in the case of religion men will face the greatest risks and undertake the most laborious tasks without hope of reward. The soldier and sailor do their duty for the poorest pay, and too often with little or no prospect of comfort for their later years, and I do not see why a corresponding devotion to duty and a corresponding desire for the general good should not create a high standard of zeal and efficiency in the ordinary service of the State where the risks are less and the rewards, if not great, are at any rate reasonable. If we look back on the Government Service in the past we see corruption and inefficiency. At the present day an enormous change has come about. We can see in every direction faithful service and high efficiency, and there is no reason why this change should not continue and increase.

I lately had the pleasure of meeting an officer of the American army who had been visiting the wonderful works connected with the construction of the Panama Canal. You have probably, all of you, read some details of the vast labour involved; how engineering and mechanical appliances have had to be provided for the removal of hills and the filling up of valleys, for the draining of swamps, and the construction of docks on a scale hitherto unknown in human

Digitized by Google

work. There are hundreds of mechanical shovels which scoop out five tons of earth at one operation. They are served by a network of railways controlled by the most intricate electrical arrangements. The earth taken out is carried off in trains, which deposit it in valleys beside the rails until it is heaped up level with the rails. Huge rollers flatten and harden the surface, and then great cranes are moved along and the railway is bodily transferred to the newly prepared surface, so that the next day the earth and rocks removed from the works can be again deposited beside the railway. The force of workers employed numbers many thousands: their houses have been built by the Government; their food is provided by the Government; their children are educated in Government schools; Government doctors look after their health; the Government provides their plays, their services, their amusements, their libraries, and takes care of every part of their lives. The district in which the work is being carried out was formerly a plague spot, and now by strict sanitation has been converted almost into a health resort. All this vast enterprise is under the charge of officers belonging to the corps of what we should call the Royal Engineers. These officers are in many cases men of the highest scientific attainments and of great energy. Formerly the Government employed civil engineers and civil officers to supervise the work, but it was found that as soon as they had proved their worth they were attracted by offers of large salaries to commercial enterprises in the United States. The officers who are now carrying out these huge works, the greatest of the kind that have ever been seen, are receiving the small pay of their army rank. They have small prospect of any high promotion, and even their names are little known to their fellow countrymen. Nevertheless the work is being so carried on that its admirable efficiency and success is one of the wonders of the world. An example of this kind in a country where commercialism is developed to its utmost, and is considered to be the leading main-spring of the national energy, is a striking example of how a State service may be developed and carried on with success.

I had the pleasure, some years ago, of visiting the United States in company with the late Mr. Gaine and Mr. Gill, and of examining very closely the organisation of the great telephone companies. As you are aware, that organisation has been worked out on what is called the functional basis under which the officers of the service are grouped, not according to class or rank, but according to their special or expert relations to the service. What struck me most was the enthusiastic and devoted manner in which officers of every rank studied their duty, not from any hope of direct or immediate benefit to themselves, but from an enthusiasm for the service which seemed to be universal. Every member of the staff, from the highest to the

Digitized by Google

lowest, with whom I came in contact was not only anxious to carry on the routine of his work in a satisfactory manner, but was also eager to improve its efficiency in relation to the other parts of the system, so as to make the whole organisation work as smoothly and efficiently as possible. There was so much co-operation between the different parts of the service, so much interchange of experience, and such eagerness for the improvement of the service as a whole, that on one occasion when I was asked to state my impressions of the American telephone system, I could only say that I knew of no other institution in which the interest of the individual was so subordinated to the welfare of the system as a whole, except the Catholic Church, and although the comparison may seem strained, there is in reality a great deal of similarity in the spirit with which the two institutions—one religious and the other commercial—are served. If we are to make sure of the success of our State telephone system in this country, we must aim at the creation of a similar spirit in all ranks, and it is because the work of this society and kindred societies tends so admirably to foster that spirit that I feel confident that we are not over-sanguine in hoping that our ideal organisation may some day be realised.

TRAFFIC DEVELOPMENT IN THE LONDON TELEPHONE DEPARTMENT.

By P. W. H. Maycock, L.T.S.

(*Continued from page 378.*)

Traffic Statistics in the Post Office System—their Object and Use.

The ultimate object of a system of statistics is to furnish a continuous and comprehensive record of growth, by which alone the experience of the past can be used to forecast the needs of the future, and it is as an indication of tendencies rather than as a record of individual results that the real value of a system of statistics lies. Above all things the system must furnish a basis for estimating the demands of the period of maximum pressure. Since subscribers as a whole judge the efficiency of the service by its efficiency during the time when they most require its use, it follows that if a telephone administration is to maintain a good record it is the periods of greatest pressure rather than the average requirements that must be provided for. To attain this, facilities must be provided in advance of the actual demand, and for a system on these lines to be economical there must be a reasoned and systematic estimate of all essen-

Digitized by Google

tial requirements conducted on uniform and well-defined lines. A system has therefore been established under which all exchanges furnish during the slacker months of the year an estimate of the probable requirements of the ensuing year in the case of—

(1) Additional positions to be opened.

(2) Staff required.

Seeing that the fundamental idea of the system is that the facilities should always be adequate to the period of maximum demand, all estimates are based on busy hour statistics. The "A" position meters at each exchange are therefore read daily at 8 a.m., 9 a.m., every half hour between 9 a.m. and 12, and at 8 p.m. The busy hour totals for each position are recorded on a form provided for the purpose, the equated value of the traffic being obtained by the application of the equating factors already described. At the end of each week the six days' results for each position are averaged. From the figures so obtained the following curves are plotted:

(1) Average busy hour load of the exchange and the maximum and minimum load of any one position.

(2) Average busy hour load of each position each week.

(3) Average equated calls per subscriber's line during the busy hour.

In addition to these, curves are also kept showing the number of subscribers' lines working on the Exchange at the end of each year and the average number of unit calls per line during the busy hour. The estimate for any desired year is obtained by extending the curve in accordance with its latest tendencies.

Since the standard "A" load is 220 unit calls, the number of positions required for a given number of subscribers depends upon the equated calling rate per line in the busy hour. For the purposes of the estimate this calling rate is based on the ten busiest days of the year. Having obtained these particulars the average number of additional "A" positions required by the end of the year will be:

$$\left.\begin{array}{l}\dfrac{\text{Estimated number of working lines at the end of the year}}{220} \\ \text{Average number of unit calls per subscriber's line in the busy hour.}\end{array}\right\} \text{Number of "A" positions now opened.}$$

At exchanges where positions meters are not fitted, the "A" traffic statistics are, of course, obtained from the tickets. Only actual subscribers' demands are counted as calls, no attempts on the initiative of the operator being included.

In the case of "B" positions, the traffic figures are obtained from the monthly peg count records, there being no provision for the automatic recording of calls on "B" positions. The number of "B" positions required in a given case is determined as follows:

Digitized by Google

$$\frac{\text{Estimated total equated calls in the busiest hour of the year}}{\text{total equated calls in the busiest hour of the previous year}}$$

220

Staff estimates are based on the estimated number of positions required. For purposes of estimate, a staff allowance of 1·5 operators per position—to cover all requirements—is assumed. Experience has shown that for the purpose of a general estimate, this allowance is on the whole satisfactory. The actual supply of staff in specific instances is, however, determined by careful study of the equated traffic throughout the day.

In addition to position and staff requirements from the standpoint of traffic load, there is the question of the provision of junctions. This is a question of great importance in the Post Office system, where junction traffic represents about 90 per cent. of the total traffic handled. Since the traffic of different junction groups increases at different rates, it is necessary that the growth of each junction group should be studied separately, and that records should be taken on each individual group regularly and at frequent intervals. Post Office practice requires a record of each junction group at least once a month. At present, estimates of junction traffic requirements are framed by the Central Office, but the question of delegating this duty also to the exchanges is under consideration.

It is the intention that junction estimates should be based on the traffic increase of the busiest month of the year as compared with that of the busiest month of the preceding year in the case of each group. From these figures curves will be plotted and estimates obtained by extending the curves in accordance with their tendencies as in the case of the estimate of Exchange lines. This, of course, will give approximately the traffic for the period covered by the estimate; the next problem is to find the number of junctions required to carry this traffic. This is determined from a series of curves for various average durations of connection or "holding times" as they are termed in America. The fundamental idea of these curves is that a junction group carrying a given load may be regarded as consisting of two parts:

(*a*) A group of junctions which would just carry the load if the calls were "lined up" and connected continuously. This represents the fully occupied junction time for the given load.

(*b*) The proportion of junctions in excess of the fully occupied group required to cover the traffic fluctuations experienced in practice and to provide the required efficiency of service.

Upon these fundamental principles curves have been constructed for the various holding times usually met with in practice, and the number of junctions required in a given case can easily be determined from them.

Digitized by Google

The foregoing gives as briefly as is consistent with clearness a description of the main traffic features of the pre-transfer Post Office system. Space—and possibly the reader's patience—forbid anything like a complete discussion of the numerous points of interest to telephone men inseparably connected with the handling of traffic.

TELEPHONE TRANSMISSION.

SINCE the articles on "Telephone Transmission" which have appeared in our last three numbers were written, the Drysdale Alternate Current Potentiometer has been developed for the purpose of telephonic measurements, and can now be used for frequencies of 1000 or more cycles per second. A series of tests has recently been made at the National Physical Laboratory at a frequency of 1000 cycles per second, and during these tests phase angle measurements were made with a mean error of only ·05 degree.

This result is remarkably good, and Dr. Drysdale is to be congratulated on his success in developing his instrument for this class of research work.

Digitized by Google

A LINEMAN'S EXPERIENCES DURING THE NORWICH FLOODS, 1912, AS TOLD BY HIMSELF.

On the morning of August 26th I cycled from Holt to Wells in search of a fault, arriving at Wells at about 2.30 p.m., with water running from my boots; it had been raining about as hard as possible the whole way. Thinking that I was entitled to a little comfort, I boarded the 3.20 p.m. train from Wells *viâ* Norwich to Cromer. Between Wells and Fakenham the train slowed up three times owing to land-slips from the railway bank being across the line; the train, however, passed these safely, and we eventually arrived at Dereham, where, after waiting thirty minutes, we were informed that a bridge had fallen across the line at Thuxton, and after considerable waiting in the cold wind and rain, we were started for Norwich *viâ* Swaffham and Thetford. All went well, though slowly, until Swaffham was reached, where we were again informed that the line was blocked between here and Roudham Junction. We again left the train, and were kept waiting, in wind and rain, when a train was brought in in order to get us to Norwich *viâ* King's Lynn, Ely, and Thetford. The train ran into Ely as if determined to reach Norwich, but was pulled up sharp, and we were informed, with scant civility, that the line was blocked ahead, and the only way open was *viâ* Bury St. Edmunds, Ipswich, and Great Yarmouth. Off we went again to Bury St. Edmunds; here we got another check, as the line had been washed away beyond Bury St. Edmunds. After another rest of thirty minutes we were taken back to Ely. This would be about midnight, where we again waited, perhaps an hour, for instructions; it would appear that the train had been lost for some time as nobody seemed to know anything about it.

Digitized by Google

Presently we were told that the railway company could not get us to Norwich, and that Brundall, which is seven miles out, was the nearest it could be approached, and that only by Liverpool Street, Ipswich and Great Yarmouth. We started for Liverpool Street, first stop, Soham; here the station was in darkness, and the rain was teeming. The train had barely stopped when a stentorian voice shouted, "All change," and of course, after scrambling for luggage and everybody had left the train, the guard asked *why* they had left, as we were only waiting for the line to be cleared before starting again. After another good wait—"I had by this time lost count of time"—we again got on the move, when a voice shouted, "Any more for the toy railway." This time we got on very nicely, and ran into Liverpool Street at 4 a.m. on the morning of August 27th. Here the Station-master put in an appearance, and was immediately surrounded by a clamouring crowd. He informed us that we should start for Yarmouth at 5 a.m. By this time my clothes were drying nicely, and I was steaming like an engine. Now came the best run of the journey, that being from Liverpool Street to Beccles, only stopping at Ipswich for a few minutes. On arrival at Beccles it was "All change" again; we waited for forty-five minutes on this platform, when the train that should have taken us to Yarmouth ran through. The crowd now swarmed to the station official, and were told that the next train would arrive at about three or four hours hence. Having had enough of trains and waiting, and in fear of being stranded further still from Cromer, where it was most important that I should have been the night before, I got out my cycle and started for Norwich by road, hoping by the exercise to keep myself a bit warmer than I had been for the last few hours, as my boots, socks and trousers were still soaked with the rain of the day before. I mounted my cycle with hope running high, only looking forward to an ordinary cycle ride of forty miles, little dreaming what was before me. For a mile or two I got on fairly well; then the roads started getting worse, and inside five miles from the start I had two punctures to mend. Then the trouble began, the road being washed quite away in some places, and in others, first one half of the road and then the other being washed away, with the water several feet deep in some cases. At one place I was riding on a path, "and that very rough," and the road had gone each side of me to such an extent that a large boiler-shaped petroleum cart was laying on its side beneath me in what should have been the road. Presently I came to a tree laying across the road; I could not get over the fence to pass this obstacle as the fields were under water, so I had to get the cycle over the tree, which was a very awkward job, it being a large tree and very thick with small growth; so, after struggling with

Digitized by Google

my cycle for twenty-five minutes I landed on the other side. I found that towards Loddon the roads had suffered very little damage and I rode through Loddon under ordinary conditions. This, however, was not to last long, as I found the bridge and part of the road washed away, barring further passage in this direction. Now, I had either to carry my cycle, which weighed about 50 lb., over a 9-in. plank fifteen yards long, with water tearing along at a rate of about fifteen miles per hour beneath me, or cycle round by Bungay or Brooke, which would increase my journey by about another ten or twelve miles, and even then I might find another bridge down on that road; so I chose the plank, and this was bending to my weight plus that of the cycle. Hen-coops, hurdles, dead pigs and chickens were passing beneath me at no doubt a greater rate than either of the latter had travelled in life. After negotiating the plank I again mounted my cycle, and found the roads fairly good except for some pools of water about one foot deep here and there, until I descended the hill into Framlingham. Here they were pulling the Great Eastern Railway motor busses out of the water and passengers were huddled in groups, looking on convinced that they would get no further by motor bus on that road. I was now within six miles of Norwich, and I knew what turning back meant, so forward I had to go. Someone shouted, "You won't get that way," and I could only answer, "I'll try," and plunged into the water, which was not deep for a start but gradually got worse, until for several hundred yards I was riding in 2 ft. 6 in. of water running against me at the rate of about seven or eight miles per hour. I was through the worst of this and mounting an incline when I found a tree fallen across the road where the water was hardly 12 in. deep and there was just room for me to ride between the bank and the end of the tree. Here, however, I came to grief for the first time as the strain of water passing the tree had washed the road, and I fell into a hole about three feet deep, luckily falling on my feet, so that I did not wet that part of the clothes which were now dry from the day before. After getting out of this I had to walk about half a mile as the road was in such a condition that it was impossible to ride, so I jumped on my cycle about four and a half miles from Norwich and was able to ride to Trowse. Here I got another check; the road was covered with water for about 200 yards absolutely too deep to either ride or walk through, and I was informed that at the other side of this two large river bridges were washed away. I lifted my cycle over five fences of all sorts and crossed various private properties, and at last arrived at the other side o the flooded street, and found to my great joy that I could walk over a part that was left of both of these bridges and at last I was in Norwich. Here, in an almost fainting condition, I stopped one and a quarter hours for a wash and some

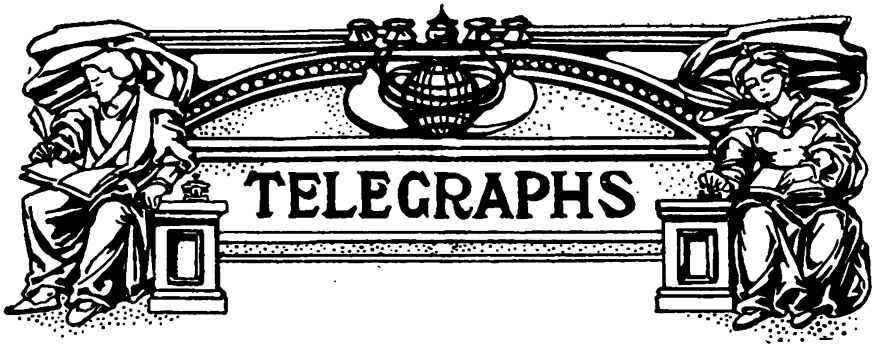
Digitized by Google

food, the first of either I had had since 7.30 a.m. of the day before, with the exception of three-pennyworth of light biscuits, and it was now 11.20 a.m. of Tuesday, August 27th. After this rest I inquired at Norwich Thorpe station for trains to Cromer and was told that the service was suspended, so I faced the next twenty-two miles with as good grace as possible, feeling much better than when I entered Norwich. I found the roads good this way except that bridges had gone, the first of which was at St. Faith's, and this not so badly but that it could be walked over in one place. The next bridge was at Hevingham, nearly eight miles from Norwich, and this could be crossed by walking over a plank laid on a ladder, which was amusement for me after what I had come through. I had not left this bridge far behind when I was overtaken by a motor-car which had evidently entered this road from a side-road. The gentlemen slowed up to speak and I held to the side of the car; in this way I travelled just a mile, which was a great help to me, as the strain of my journey and my exposure was again beginning to tell on me. I left the car at Marsham, and had proceeded about half a mile when I again had about two hundred yards of water eighteen inches deep to cycle through, after which I had no difficulties until I reached Ingworth, nine miles from my destination. Here another bridge was washed away and several acres of marshland flooded, over which people were being rowed to the other side in a boat. Only one boat was at work; this could carry about six passengers, and when I arrived there were about forty people waiting and others arriving fast. Every time the boat came to our side there was a scramble as to who should go, and I, being at a disadvantage with my cycle, could not get over until I had waited some long time; the fare for the trip was a shilling. On arrival at the other side I found that waggonettes were running people from this point to Cromer, and waiting for one of these to start I held on and let it pull me through as the road had suffered very little this way, and I arrived at Cromer Post Office at 5 p.m., after travelling over 350 miles. I was then at work until 9 p.m. that night clearing lines, and I can assure my reader that I wanted less rocking that night than I did any other night of my life. The distance from Wells to Cromer is twenty-two miles, and this had taken me twenty-six hours of experiences such as I hope never to see again.

G. E. SEACH,
Post Office Telegraphs, Cromer.

[The Board of Editors feel sure that the foregoing article will be read with great interest as an indication of marked devotion to duty shown in exceedingly trying circumstances.]

Digitized by Google



THE TELEWRITER.

WHILE this ingenious instrument has been described in many technical papers, there are, no doubt, many of our readers who are not acquainted with the apparatus.

Briefly, as its name denotes, the telewriter is an instrument for the electrical transmission of handwriting, figures, sketches, or any other signs which may be made by the sender.

It has now come into such extensive use, and fills such an important field, that a description of the apparatus with its circuits is not only interesting, but necessary to those who intend keeping abreast of the times. Before proceeding with the descriptive matter it may be well to point out that under the terms granted by the Postmaster-General for the use of the telewriter in the United Kingdom, two telewriter exchanges are in operation in London, which have at present about eighteen lines running into the Central Telegraph Office. Each line is equipped with a telewriter, which, at the G.P.O., receives telegrams for transmission direct from any subscriber, or is used for the instant delivery of telegraph messages. Every subscriber has, of course, the same facilities for communicating in writing with any other subscriber. The writing is done at the transmitter and receiver, on rolls of paper 5 in. wide, which are simultaneously moved forward as required by the person sending the message.

The main principle employed in the telewriter is that of producing two independent motions by the movement of the transmitting pencil, each motion causing a gradual change of current through a line wire.

At the receiver these varying currents produce independent motions, the resultant of which is a reproduction of the transmitted message.

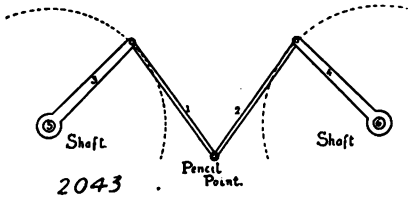
For the clear conception of the means by which this is accom-

Digitized by Google

plished, the transformations and movements involved will be treated independently under the following headings:

(*a*) Transforming the movement made by the transmitting pencil into semi-rotary motions of two shafts.

(*b*) The movement of these shafts controlling the current sent to the line wires.



1.—Pencil Mechanism of Telewriter.

(*c*) The line currents producing semi-rotary motions of two shafts at the receiver.

(*d*) The receiver shaft motions transformed into a reproduction of the transmitting pencil movement.

(*e*) Paper feeding.

(*f*) Pen lifting.

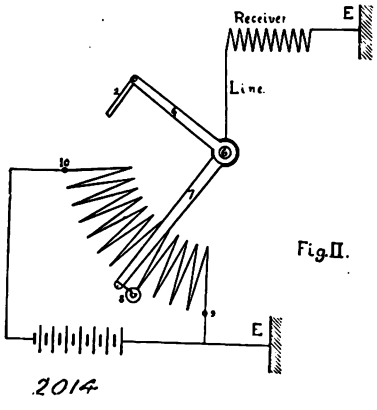


Fig. II.

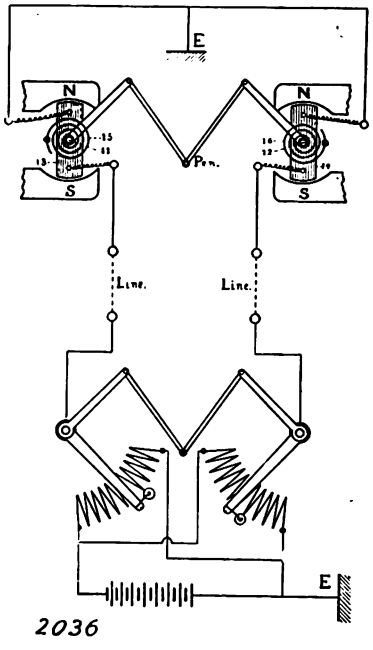
2.—Potentiometer Circuit of Telewriter.

The manner in which these principles are employed and the movements produced will now be explained.

(*a*) Transforming the Movement made by the Transmitting Pencil into Semi-rotary Motions of Two Shafts.—In 1 will be seen the transmitting pencil. Jointed, near its point, are two rods, 1 and 2, which have their other ends jointed to levers 3 and 4. These levers are rigidly attached to shafts 5 and 6. It will be seen that any motion given to the pencil will produce independent and varying turning movements of the shafts.

Digitized by Google

(*b*) THE MOVEMENT OF THESE SHAFTS CONTROLLING THE CURRENT SENT TO THE LINE WIRES.—2 shows shaft 6 (corresponding to 6, 1) having rigidly attached to its lower end a lever, 7, which carries a contact roller, 8, connected to line wire. This roller makes connection with a potentiometer, connected as shown in diagram. The full voltage of the battery or electric supply is represented between earth and point 10, and any lower voltage may be sent to line by movement of roller 8 toward point 9. The resistance of the line being constant, the current will be in proportion to the voltage. A similar potentiometer is arranged to be operated by



3.—WRITING CIRCUITS OF TELEWRITER.

shaft 5, 1, and both are shown with their connections in the lower part of 3.

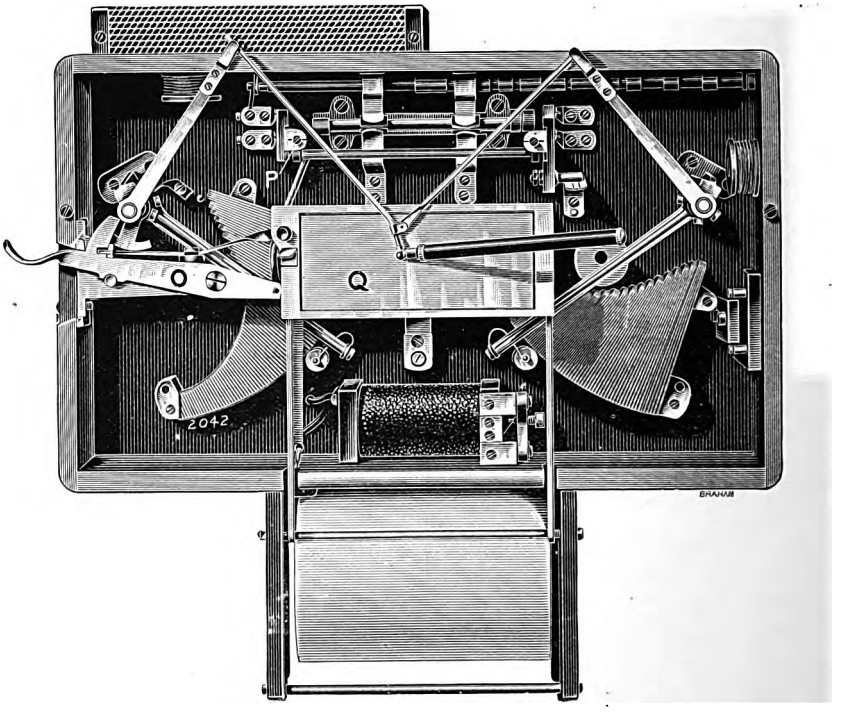
(*c*) THE LINE CURRENTS PRODUCING SEMI-ROTARY MOTIONS OF TWO SHAFTS AT THE RECEIVER.—The upper part of 3 shows two shafts, 11 and 12, to which are attached moving coils 13 and 14, and springs 15 and 16. These moving coils have their windings in the line circuits and take up positions in accordance with the current passing through them. The control springs 15 and 16 are so calibrated that the turning movements of the shafts 11 and 12 correspond in extent with the potentiometer shafts 5 and 6.

(*d*) THE RECEIVER SHAFT MOTIONS TRANSFORMED INTO A REPRODUCTION OF THE TRANSMITTING PENCIL MOVEMENT.—

Digitized by Google

Having obtained corresponding movements in the receiving shafts to those of the transmitter, it now remains to convert these into a reproduction of the motion given to the transmitter pencil. This is done by connecting the receiving pen to the shafts by a link motion having the same dimensions as 1.

(*e*) PAPER FEEDING.—The movements of the transmitting pencil and the receiving pen being limited in extent, it is necessary that the paper shall be fed over the available writing space. This is done mechanically at the transmitter and electrically at the receiver.



4.—INTERIOR VIEW OF TELEWRITER TRANSMITTER.

In 4 (which is an interior view of the transmitter) is shown a finger lever at O connected at its inner end by a rod to the paper shifter P (an enlarged view of which is shown in 6).

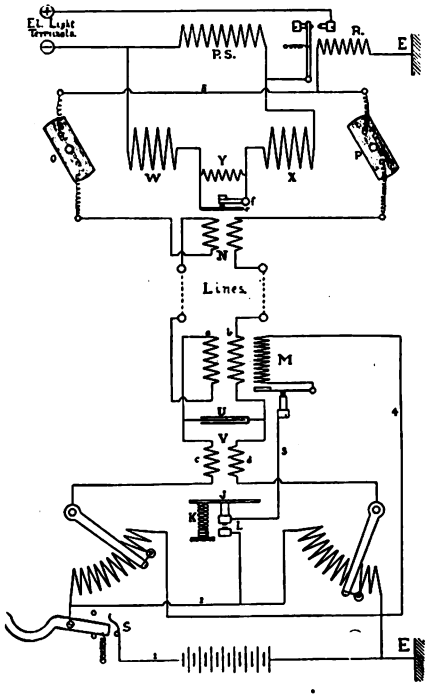
When lever O is moved to and fro between its stops, the paper shifter rocks back and forth and feeds paper over the platen Q at each movement. Actuated also by the finger lever O is a switch, which is placed in the battery circuit as shown at S in 5.

At R, 5, is shown a relay winding, placed in the common return circuit. When the switch S is closed current passes through the lines, operates relay R, and by its contacts closes the circuits through paper shifter PS, which when energised feeds the paper forward one step.

Digitized by Google

This occurs at every shift, because the switch S is operated each time the operator shifts his paper a step. Relay R also controls a circuit which includes field magnets W X and pen lifter Y.

(*f*) PEN LIFTING.—At the transmitter, movements are made both on and off the paper, and it is necessary to provide means for raising and lowering the receiving pen accordingly. This is accomplished by sending a superimposed alternating current over the lines, and will now be explained. Referring to 5, J is the hinged platen over which the transmitter paper passes. It is held in its upward

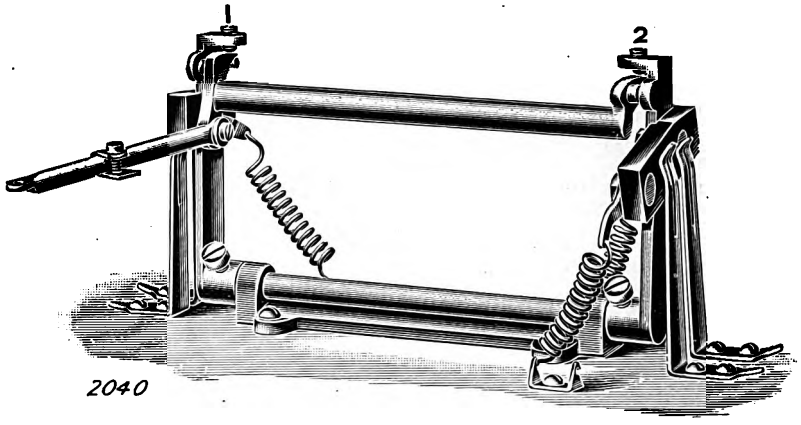


5.—COMPLETE CIRCUITS OF TELEWRITER.

position by spring K, and is brought to its downward position by the pressure of the operator's pencil in writing. In the latter position contacts are closed at L, which completes a circuit through the break and primary winding of induction coil M by wire 1, switch S, wire 2, contact L, induction coil M, and wire 4. The induction coil M has differential secondary windings, *a* and *b*. These are included in the line circuits, but in relatively reverse directions, so that at any given moment the induced current in one line will be in the opposite direction to that in the other. *c* and *d* are windings of a choke coil also in the line circuits, the function of which will be referred to later. From the foregoing it will be seen that whenever the

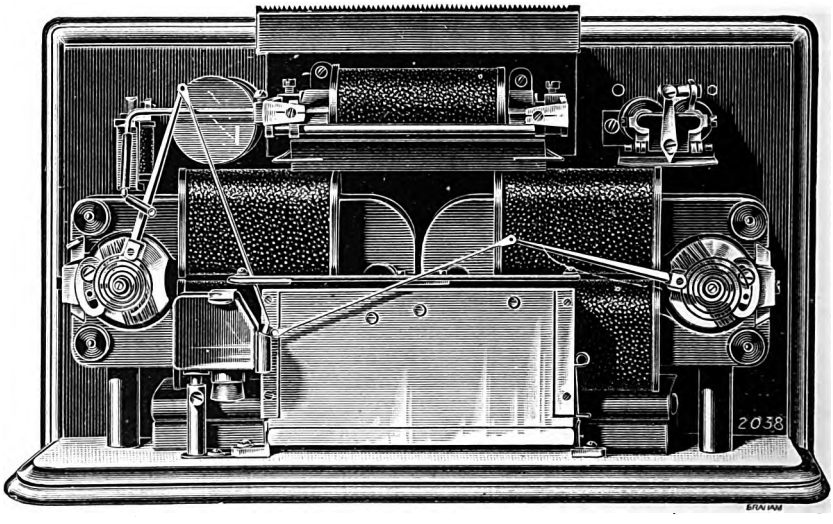
Digitized by Google

operator's pencil is "on" the paper, the induction coil M is brought into operation, and that an alternating current induced in the secondary windings is superimposed upon the writing currents



6.—Transmitter Paper Shifter in Telewriter.

passing through the lines. At the receiver this alternating current passes through the differential windings of a vibrator N, moving coils O, P, and wire 5. The vibrator N has over its core a reed *e*, upon

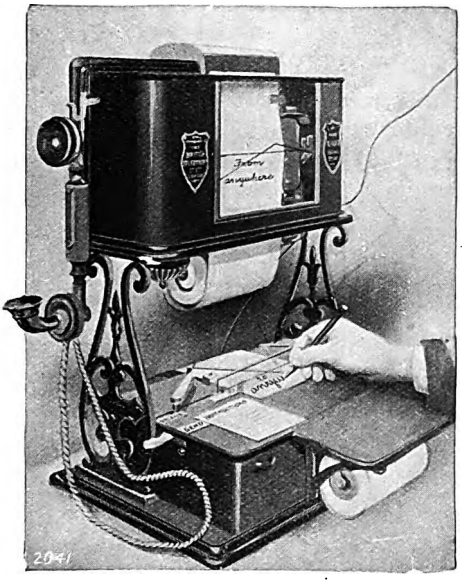


7.—Interior View of Telewriter Receiver.

which rests a weighted lever *f*, the contacts of which shunt the winding of pen lifter Y. When the transmitter platen is depressed the current from induction coil M causes the reed *e* to vibrate. This increases the resistance between the contacts of *e* and *f* to such an

Digitized by Google

extent that current passes through the winding of pen lifter Y, causes its armature to be attracted, and allows the receiving pen to rest



8.—Exterior View of Complete Telewriter Instrument.

upon the paper. When the induction coil M is inactive the contacts of vibrator N are at rest, forming a shunt of such low resistance that the pen lifter Y is inert. Under this condition a spring moves the arma-

9.—Operating the Telewriter.

ture of Y forward, and thereby raises the pen from the paper. To prevent disturbance in neighbouring circuits, the alternating current is confined to the lines by means of condenser U and choke coil V.

Digitized by Google

The condenser forms a path for this current, and the inductance of V prevents it passing to earth.

The receiving pen, when not in use, is held in the ink-well by rod 1, 7.

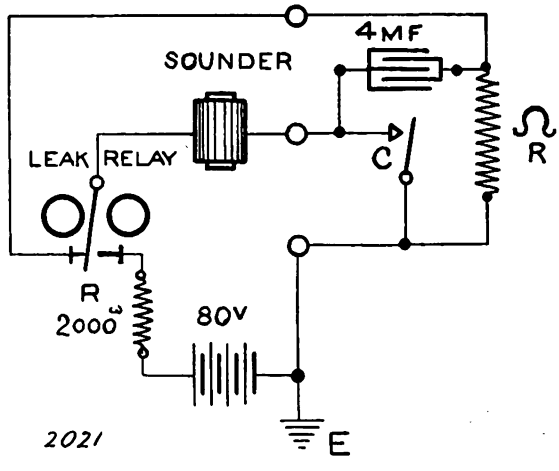
It is also brought to this position every time the paper is shifted, and is thus kept fully supplied with ink.

If required, other telewriter receivers may form part of the exterior circuit, and be simultaneously operated from the one transmitter.

NEW IDEAS.

SILENCER No. 3.

Mr. J. J. Hardie's article on "Sounder Silencers" in our number

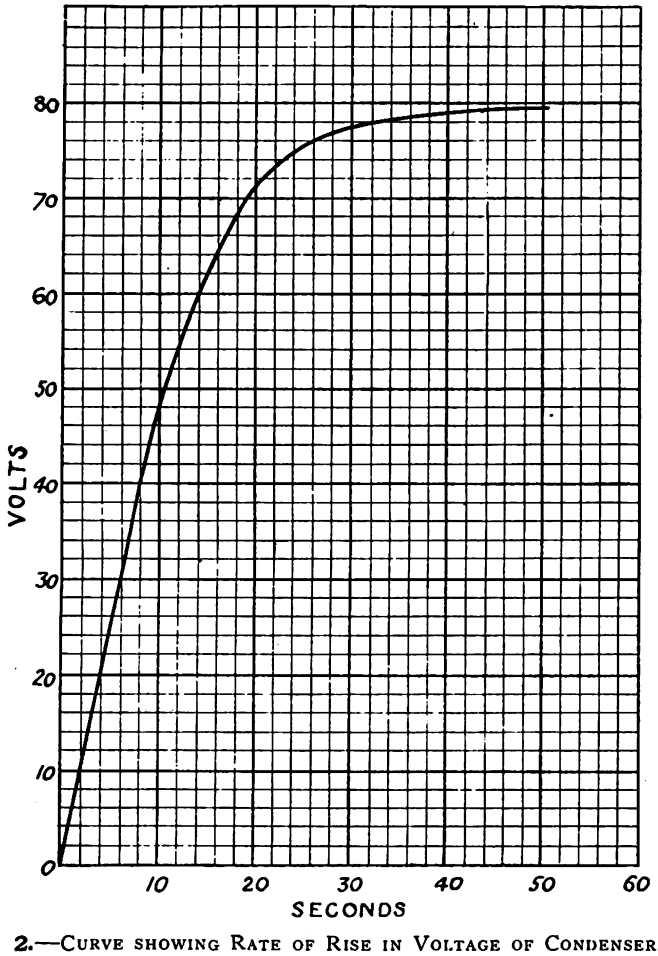


1.—Device suggested by Mr. Donald Murray for the Reception of Calls on the Sounder at Repeater Station.

of July, 1909, described, among others, a form of silencer based upon the principle of charging a condenser very slowly through a high resistance. This type has now been further developed and has been introduced as a standard departmental item with the title of "Silencer No. 3." The utilisation of the principle mentioned was first proposed by Mr. Donald Murray, who suggested the arrangement shown in 1. Our readers will generally be aware that sounder silencers are associated with telegraph circuit repeaters. They are fitted at offices where several repeaters are installed, and their object is to prevent the sounders, with which each repeater is equipped,

Digitized by Google

from responding to the signals passing over the line under ordinary conditions. In the absence of silencers the two sounders on a duplex repeater would reproduce all the signals passing in both directions, and it will readily be understood that the attendants at a repeater station would have to exercise continuous vigilance in order to recognise and to attend to the calls for aid, which are occasionally

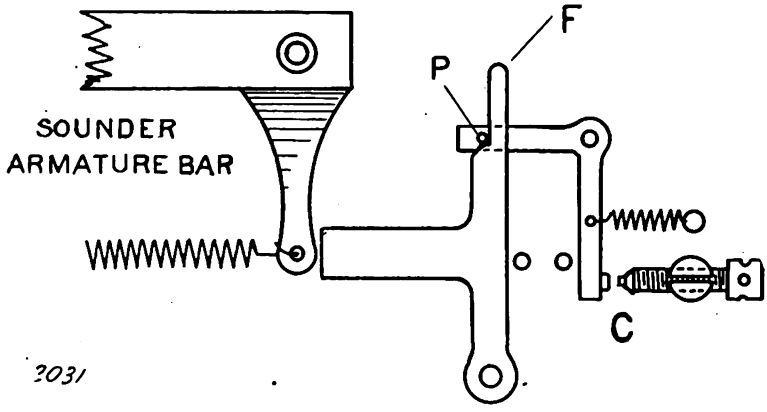


2.—Curve showing Rate of Rise in Voltage of Condenser.

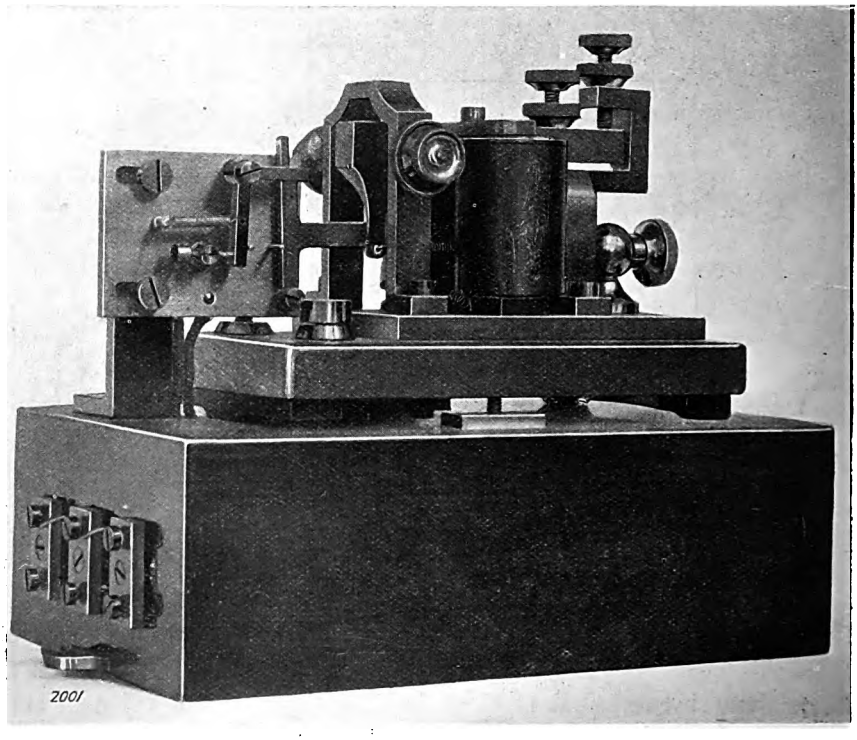
sent them by terminal stations in difficulties, if the voice of the appealing sounder were merged in the clatter of ordinary traffic on the adjoining repeaters. The fitting of silencers obviates this inconvenience. The arrangement must provide means by which a terminal station can, at will, bring the sounder at the repeater station into circuit to receive a call when attention is required. In

Digitized by Google

all forms of silencer which the Post Office has used this operation is accomplished by holding down the signalling key for a period of



3.—Mechanical Device for the Reproduction of Signals passing through the "Leak" Relay.

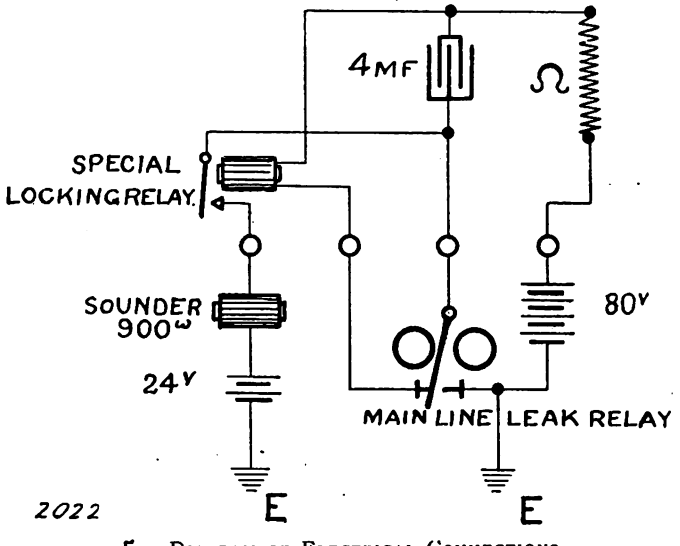


4.—The Fitting is Constructed to Act as a Stand for the Sounder.

about twenty seconds and thus sending a prolonged "marking" signal though the relays on the repeater board.

Digitized by Google

It will be seen from 1 that, in the device suggested by Mr. Murray, the actuation of the main line "leak relay" by the working signals closes the circuit of a local battery of 80 volts through a resistance of one megohm and a condenser of 4-mf. capacity. When the relay tongue falls back against the "spacing" stop, on the cessation of a signal, the condenser discharges through a special relay, but the duration of an ordinary signal is too short to allow the condenser to take up a sufficient charge to affect the relay when discharged through it. The rate of rise in the voltage of this condenser, when charged by a battery of 80 volts through a resistance of one megohm, is shown by the curve 2 which was



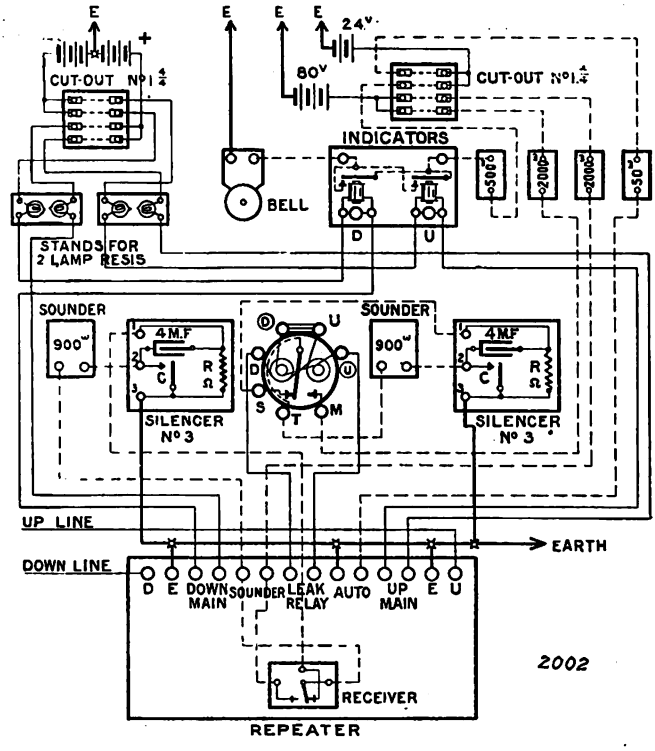
5.—Diagram of Electrical Connections.

obtained from readings taken at intervals of one second on an electro-static voltmeter joined across the condenser.

From the curve it is evident that the prolongation of a "marking" signal for about twenty seconds will allow the condenser to become charged to nearly the full voltage of the battery. When the tongue of the relay falls back on the cessation of the signal the condenser will discharge directly through the special relay with maximum effect. It was intended that the relay should be adjusted to respond to this discharge, and that it should be furnished with a mechanical locking device which would retain the armature in the closed position and so maintain the circuit of the local sounder until the relay is reset by hand to its normal open position. A silencer on this plan was never actually constructed, because a little experiment showed that the sounder itself could readily be adjusted to respond to the "kick" from the fully charged condenser. A trigger was arranged

Digitized by Google

in such a position that it would be mechanically actuated by the tail piece of the armature bar of the sounder in such a way as to overturn a balanced ball race and so close a contact in the sounder circuit. This is the form described in Mr. Hardie's article of July, 1909. It was not considered entirely satisfactory, and further efforts were made to simplify and improve it. The mechanical arrangement of the form now adopted, which is exceedingly simple, is shown in 3. The contact "C" is normally held open by a pin "P" resting on a trigger which is struck away by the tailpiece of the sounder armature



6.—Diagram of External Connections of a Duplex Repeater equipped with "Silencers No. 3" on its "Up" and "Down" Sides.

bar in response to the kick from the charged condenser. The closing of the contact "C" short-circuits the condenser and megohm and thereafter permits the sounder to reproduce freely the signals passing through the leak relay. The trigger is reset by the finger-piece "F," which can also be used to throw back the trigger and bring the sounder into circuit at any time when the repeater attendants may wish to supervise the working of the line.

This form of silencer is much the cheapest yet devised. It is constructed to act as a stand for the sounder—see 4. The megohm resistance consists of a thin layer of graphite sealed between two

Digitized by Google

strips of ground glass with tinfoil end connections. The purpose it has to fulfil does not, of course, call for a very accurately standardised resistance.

The electrical connections, which are very simple, are shown in 5.

Only one battery is used and there is no permanent current, or permanent voltage strain, upon the condenser or the megohm. 6 shows the external connections of a duplex repeater equipped with Silencers No. 3 on its "up" and "down" sides.

T. F. P.

A SIMPLE MESSAGE CARRIER.

By H. A. Miles.

A need has hitherto existed for a cheap and simple means of transferring telegrams from the counter to the instrument at small offices, where the instrument is in the public office or an adjacent room, and the expense of a pneumatic tube or more elaborate carrier could not be justified.

There are several appliances on the market in which the travelling message clip is impelled along a wire or wires, either by a strong rubber spring, or by the forcing apart of two wires. Both these methods are somewhat noisy and cost more than is desirable; the sending and receiving points are also at a considerable height above the floor level.

The ideal system is one which would enable the counter clerk to insert and despatch a message with the minimum of "reaching up," and would deliver it within easy reach of the seated telegraphist.

A further important point is that if the telegraph instrument is not in sight of the counter, the counter clerk requires to know whether the message is duly received, or whether it merely flutters on to the table and escapes notice.

All these requirements are well met by a little carrier recently installed at the Dover Street B.O. (London, W.). The principle involved is that of the see-saw, and a reference to the accompanying sketch will render the following description quite clear.

A B C D is a rigid trussed frame rocking on a fixed pivot at D* and carrying a strained wire upon which the message clip E is free to travel from end to end.

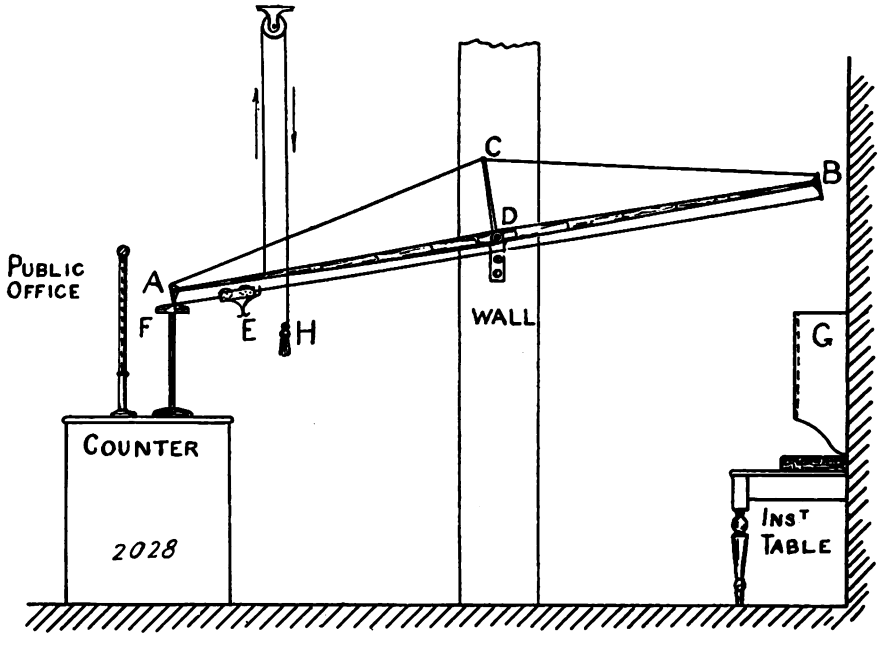
F is a padded platform upon which the weighted end A normally rests, and G is a glass-fronted shoot through which the message reaches the operator at the instrument table.

* At Dover Street B.O. a wall was conveniently situated for supporting the pivot bracket at D. In other circumstances a ceiling support would have been provided.

Digitized by Google

The *modus operandi* is as follows: The message is inserted in the clip E by the counter clerk, who then pulls the handle H, thus raising the end A and lowering B until the latter touches the top of the shoot G, where it is automatically secured by a spring catch. The travelling clip E has meanwhile run down the wire and automatically released its contents, which flutter down the shoot G into a tray or basket upon the instrument table.

The return of the carrier to its normal position can be effected only by the telegraphist releasing the spring catch by pulling a cord



THE "SEE-SAW" MESSAGE CARRIER.

alongside the telegraph instrument. The return of the carrier thus acts as a receipt for the message, and if a message should arrive during the absence of a telegraphist, the counter clerk would be aware that it was not receiving due attention.

This see-saw carrier was suggested and the design worked out by Mr. E. D. Hebden, of the Headquarters Drawing Office Staff, and the automatic release for the message clip was suggested by Mr. J. Gillard, a mechanic in the Metropolitan Central District.

The carrier was constructed within a week at the Holloway factory in order to be ready for the Christmas pressure (1911), during which it proved of great value. It still continues to give full satisfaction.

Digitized by Google

OUTSTANDING PROBLEMS OF WIRELESS TELEGRAPHY.

By F. W. Davey.

Prof. J. A. Fleming, in his introductory remarks at a joint discussion by Sections A and G of the British Association at the meeting at Dundee in September last, has rendered signal service to the art of radio-telegraphy. The service lies not so much in the elucidation of new phases of the art, but in focussing attention on, and crystallising ideas concerning, the outstanding problems of radio-telegraphy. It may therefore be of interest to give some brief outline of the problems thrown down for discussion, together with a few remarks thereon, as they appeal to a Post Office Engineer.

After describing in general terms a modern radio-station utilising intermittent trains of waves generated in a closed oscillating circuit by the discharge of a condenser across a spark gap, and radiated from a radiating circuit coupled to the closed circuit, as distinct from stations using continuous trains of waves, Prof. Fleming proceeds to enunciate the problems. Most of us are familiar with the details of such a station, so no further preliminaries are necessary.

It is premised that the mechanism by which radio-telegraphy is effected is Hertzian waves, with the hypothetical æther as the medium of propagation. Starting from the premise the question is propounded as to the modifications necessary to pure Hertzian waves, or the radical differences which exist between these waves and those utilised in radio-telegraphy, to account for propagation round one eighth of the earth's curvature, and even over larger distances. The fallacy of the consideration of the problem from the point of view of a perfectly conducting surface with a Hertzian oscillator entirely detached from it is emphasised, and it is pointed out that three important factors are involved in the propagation of electric waves over the earth's surface: first, the imperfect conductivity and rather high dielectric

Digitized by Google

constant of the earth's crust, making it a semi-dielectric; secondly, the effects of atmospheric ionisation, natural electrification and sunlight; and thirdly, the earth's curvature.

A mathematical analysis of the question as presented by Prof. A. Sommerfeld is epitomised, and, taking into account the conductivity, permeability and dielectric constant of two media at the boundary surface of which is placed a Hertzian oscillator, it is shown that radiation consists of two parts: one, surface or cylindrical waves which follow round the surface, and are analogous to the electromagnetic waves produced on wires; the other, space or Hertzian waves. Space waves are hindered by obstacles and are subject to diffraction, whereas surface waves pass round and are unhindered by the curvature of the surface; moreover, the surface waves decrease in amplitude more slowly with distance; the surface waves survive when the space waves are extingushed. Admitting the validity of Sommerfeld's investigation as applicable to the practical conditions in radiotelegraphy, the propagation of waves over large curvatures of the earth's surface no longer presents difficulty: such propagation is due to the surface waves, and the hitherto supposed diffraction effects on space waves need no longer be considered as a solution of the problem. It is interesting to note in connection with this that high antennæ are not essential for the reception of electro-magnetic waves at long distances. This was shown to be the case by Marconi in 1906. Recently Dr. Kiebitz has given the results of experiments with antennæ placed in ditches one metre deep and carried on insulators; the antennæ were earthed at the ends through condensers, and the receiving apparatus was placed at the centre; reception was effected from very distant stations by these contrivances.

The postulation of these surface waves is very alluring as an explanation of the phenomena, were it not that the condition of the atmosphere is a material factor in determining the distance over which communication can be effected. The distances covered by night greatly exceed those covered by day: the effect is generally known as the sunlight effect. Two theories have been advanced to account for this: (1) that it is due to the effect of light in discharging the sending antennæ, somewhat after the manner of the discharge of an electrified body when ultra-violet light falls upon it; (2) that it is due to the ionisation of the air by sunlight, giving it increased conductivity, and so producing absorption of the electric waves. Against the first it is pointed out that the sunlight effect is essentially a cumulative or long-distance effect; against the second, that measurements of electric conductivity of the air so far made show it to be too small to account for the observed wave attenuation. Prof. Fleming offers the following as a possible explanation. The upper layers of the air ionised by sunlight act as condensation nuclei

Digitized by Google

for water vapour. The presence of these water spherules gives the upper air a large dielectric constant, and hence a smaller velocity constant for such medium. The effect of this is to bend the wave backwards, thus directing the ray upward, so that it passes over the receiving station and does not affect it. Results of experiment with steam-impregnated and ordinary moisture-saturated air are given which appear to confirm the explanation, but it is entirely at variance with the idea that long-distance communication is effected chiefly by surface as distinct from space waves.

It is common knowledge that there is a great falling off in the intensity of signals at sunrise, and a gradual recovery of strength (known as the sunrise nick in the signal intensity curve), but the recovery is by no means complete, inasmuch as the signalling distance is not more, and in most cases less, than half in daytime of what it is at night. Prof. Fleming accounts for this by the fact that at sunrise the greatest difference exists between the state of the upper air as regards ionisation and that near the earth ; "later in the day convection currents arise to churn up the air and bring it into a more homogeneous condition, which, whatever may be the state of the ionisation, is unproductive of any tilt in the wave front." Presuming Prof. Fleming's explanation to be correct, particularly in regard to convection currents bringing about homogeneity of the atmosphere, it would follow that the time of recovery to maximum range of communication would be much earlier in summer than in winter, but this is not the case. It is a significant factor that maximum range of communication is at all times of the year nearly coincident with maximum darkness.

The next problem thrown down for discussion is the present state of the theory of directive antennæ. It is pointed out that the function of the directive antennæ is intimately bound up with the consideration of the conductivity of the surface over which communication is effected. Passing to what may be considered of especial importance as a practical problem appealing to the engineer, as distinct from what may, I think mistakenly, be termed the academic aspect of radio-telegraphy, Prof. Fleming says that the chief problem yet to be faced in connection with sending antennæ is to find a form of antenna which will radiate a large power, say 100 k.w. to 500 k.w., at a relatively low frequency or long wave length with high antenna efficiency. Engineers will agree with him when he says that there is room for an immense amount of research yet on improved forms of antennæ.

The problems set forth resolve themselves, in the main, into consideration of the surface wave theory, and the older theory, postulating a layer of reflecting medium in the upper strata of the atmosphere. The final solution must be left to the physical and

Digitized by Google

mathematical giants, but it may not be inappropriate for the lay engineer to set forth some views concerning the matter. The surface wave theory, postulated as an explanation of communication over large curvatures of the earth, is not a complete answer, inasmach as it offers no explanation of the sunlight effect: on the other hand, surface waves, as demonstrated by Marconi and Kiebitz, would appear to exist. Antennæ used both for transmission and reception would appear to make use of both the surface and the space waves, and the question arises whether this is an efficient arrangement.

Granted the existence of distinct surface and space waves, it calls for consideration whether the velocity constants are the same for both kinds of waves. Should they be different it is conceivable that for a definite wave length transmitted, the surface and space waves are out of phase one with the other by 180° at critical distances, and hence, granted the same amount of energy pertaining to each kind of wave, complete interference would result at receiving points at these distances, and at other critical distances maximum intensity of signals would be observed. This is the extreme case, but from a practical point of view it would be interesting to learn whether signals received at, say, a ship installation from a fixed station towards which the ship is travelling at a constant speed exhibit regular variations in strength. Should such be exhibited, it calls for consideration whether special receiving aërials erected near the ground to utilise only the hypothetical surface waves should be provided as a more efficient arrangement than that at present in vogue.

Although there is no direct proof that there exists a layer of ionised air of sufficiently defined surface to cause wave reflection, the postulation of such layer has much to recommend it as an explanation of the sunlight effect, and the propagation of waves round the curvature of the earth. The salient features in connection with these are: (1) the sunrise nick in the signalling intensity curve; (2) the greater signalling night distances as compared with day; (3) the coincidence of greatest signalling distance and the period of maximum darkness; signals reach their maximum intensity soon after midnight. All are intimately connected with sunlight, and it is therefore admissible to look for an explanation with this central idea in view.

Presuming that a layer of ionised air exists of boundary sufficiently definite to account for reflection, and bearing in mind that the earth acts as a reflecting surface, it is conceivable that propagation of waves over large distances is effected by successive reflections at the ionised layer and at the earth's surface, somewhat after the manner of a beam of light focussed upon one of two plane parallel mirrors. Each reflection is accompanied by loss, and

Digitized by Google

the greater the number of reflections the greater is this loss. Again, assuming that the boundary line of the ionised layer is brought nearer the earth by the action of sunlight upon the atmosphere, or, more definitely, that the boundary line follows the geometric shadow of the earth, it can be conceived that the boundary line, considered from a particular point of the earth's surface, undergoes variation such that for different angles of incidence of sunlight upon the surface, the angle of incidence of electro-magnetic waves upon the layer is different; hence the number of successive reflections between two particular points varies from hour to hour. It follows that at sunrise the slope of the layer would be steepest at the particular point, and hence the angle of incidence would be a minimum, and the concomitant number of successive reflections of waves emitted from the point a maximum. At maximum darkness the boundary line of the layer may be conceived to be of regular shape, approximating to a plane parallel to the earth's surface, and hence the number of successive reflections a minimum. Such is the bare outline of a possible explanation of the three salient features of diurnal variation enumerated above. Mathematical and physical analyses of the conditions regarding the changes in shape of the hypothetical ionised layer are necessary in order to make the changes consistent with observed phenomena: careful scheduling of signalling intensity between long-distance stations would be of material assistance in the analyses. It is emphasised that changes in shape of the boundary line of the ionised layer have been considered from a particular point; should successive reflections occur we should expect to find, so far as communication between, say, Clifden and Glace Bay is concerned, that the simultaneous signalling intensity curves for these stations do not coincide in shape, but coincide when referred to the local times of the two stations. Another possible corollary of the depression of the boundary line by the action of sunlight as postulated is that difference in range of communication may be experienced in the north to south and east to west directions; it is remarkable that such differences have been observed: maximum range of communication pertaining to the direction of the meridian, and minimum range at right angles thereto. The earth's magnetic field has been suggested as a possible cause of the phenomenon on account of the coincidence of direction of maximum range of communication, and that of the lines of induction of the earth's magnetic field. Examination, however, of the modifications in waves in the æther resulting from the superimposition of lines of strain due to a magnetic flux shows that it cannot be the cause, inasmuch as analogous effects in light are very small, and vary inversely as the square of the wave length. The vast difference in wave length of

Digitized by Google

light and electro-magnetic waves used in radio-telegraphy need scarcely be emphasised.

Further to the idea of reflection at the earth's surface the somewhat remarkable long-distance communications effected in a southerly direction by North Foreland wireless station are significant. Communication is often effected with ship stations over a strip of the Mediterranean to the south of the Gulfs of Lyons and Genoa, although the intervening land is of, apparently, a screening character. The high masses of land forming the Alps, and the Jura, Vosges and Pyrenees ranges may possibly act as reflecting surfaces with a common focus in the neighbourhood of North Foreland. I believe like idiosyncratic ranges of communication in various directions are observed at other stations.

The especial importance of all that has been said lies in practice, not so much in its aspect to ship-to-shore communication but in its bearing on communication between two fixed stations. In ship-to-shore communication attention need only be paid to the location of the land station, whether the site is free from screening in the general direction over which communication is desired, and other relatively minor factors, but with two fixed communicating stations, the possible interference of surface and space waves (presuming such separate waves to exist), arising from their different velocity constants, calls for consideration. It may be found that for given fixed stations there is a critical wave-length to give best communication.

The question of directive aërials is also of especial importance in this connection: this and the elimination of atmospheric disturbance are the chief questions to be considered in the establishment of fast-speed communication between long-distance fixed stations. Too much emphasis cannot, I think, be laid on this problem of eliminating atmospheric disturbance without material loss to the intensity of the received signals. Attempts to maintain fast-speed working when the received signals are deformed by atmospheric disturbance are tantamount to attempting fast-speed working over an aërial line subjected to weather contacts. Practical telegraphists will appreciate the simile, and most will, I think, agree that such conditions call for drastic treatment: change the line, or if no other line is available reduce to key speed working. Unfortunately we cannot "change the line" in radio-telegraphy, but once a means is found of efficiently eliminating atmospheric disturbance, what possibilities open for fast-speed radio-telegraphy! So far as speed is concerned there is no KR law to hamper us. Our chief concern therein lies in the design of transmitting apparatus with the greatest over-all efficiency, that is, the ratio of power put into the system to that radiated from the transmitter: at present this is comparatively low, but much is being done to increase the efficiency.

Digitized by Google

The question of elimination of damping losses, both ohmic and radiative, at the transmitter itself is receiving attention. The question of economical combination of apparatus and their related electrical values to give maximum power to the transmitter has lately been crystallised in a paper by Mr. L. B. Turner published in the 'Electrician' of August 2nd, 1912.

Prof. Fleming appeals for co-operation of all concerned in solving the outstanding problems of radio-telegraphy—the mathematician, the physicist, the engineer, and the practical telegraphist; such co-operation cannot fail to be of material assistance. Hitherto the mathematician has often set forth what can only be of academic interest, or where of practical interest, the service has often been minimised because the deductions have not been accompanied by physical concepts of ideas evolved. The physicist often fails to realise practical conditions; the engineer, realising, perhaps too well, practical conditions, tends to become conservative in his outlook; the practical telegraphist, whose help can be of such material assistance, has often failed to schedule correctly his observations; but co-operation between all should make for rapid progress in the art of radio-telegraphy.

DIRECTIVE WIRELESS TELEGRAPHY.

Abstract of a paper read before the Metropolitan Centre of the Institution of Post Office Electrical Engineers on December 9th, 1912.

By F. ADDEY, B.Sc., A.M.I.E.E.

AN ordinary wireless station radiates its waves in all directions, and receives signals from all directions. For many purposes this is a great advantage. In certain circumstances, however, it is desirable to limit the transmitted signals to a definite line, or to receive only those signals which come from a particular direction, and to meet this requirement several directive systems of wireless telegraphy have been devised.

After Hertz had made his discovery of electric waves he performed experiments in his laboratory in which the waves were directed along definite lines by means of parabolic mirrors. Such experiments, however, belong rather to the field of electro-optics than to that of wireless telegraphy.

In Marconi's original patent of 1896 he describes the use of parabolic mirrors for directing the waves along a definite line, and so increasing the range of communication in that direction.

The use of mirrors, however, is only possible when their

Digitized by Google

dimensions are large compared with the length of the waves with which they have to deal.

With the wave-lengths used in present-day wireless telegraphy it would be quite impracticable to build mirrors large enough, and it has been necessary to devise other methods of solving the problem of directive wireless telegraphy.

In 1899 S. G. Brown invented a directive system in which two vertical aërials, half a wave-length apart, were used. These aërials were thrown into oscillations differing in phase by half a period by having their lower extremities joined to a spark gap and induction coil. No earth connection was used.

Interference occurred between the two sets of waves thus set up, and the resultant maximum radiation took place in either direction in the plane of the aërials.

For receiving, two aërials, half a wave-length apart, and joined at their lower extremities through a coherer were used. These aërials were erected with their plane pointing towards the distant station. When signals were received, oscillations were set up in the aërials differing in phase by half a period, and which, therefore, helped one another in the connecting path through the coherer. Thus the signals were recorded.

In the same patent S. G. Brown described an arrangement in which, instead of aërials, plates buried in the earth half a wave-length apart were used. The maximum radiation occurred along the line joining these plates.

In 1904 Braun patented a directive system in which two aërials half a wave-length apart were employed, but in which the lower extremities of the aërials were earthed, and the oscillations in them excited, through inductive couplings, from a closed oscillating circuit.

In 1905 Marconi invented a directive aërial shaped liked the letter L turned upside down. Such an aërial was found to radiate or receive best from a direction opposite to that in which the horizontal portion of the aërial pointed.

In 1907 Bellini and Tosi invented a system in which two non-earthed vertical aërials half a wave-length apart were used, in which the oscillations, which differed by half a period in phase, were excited through an inductive coupling from a closed oscillating circuit. These two inventors, by the addition of a third aërial halfway between the two original aërials, in which oscillations were set up, differing by a quarter of a period in phase from those in the other two aërials, were enabled to suppress the radiation in one direction in the plane of the double aërial, and thus to confine the radiation to one definite direction.

The Telefunken Company have produced a directive aërial

Digitized by Google

shaped something like the letter W turned upside down, with very wide angles. The transmitting apparatus is joined to the middle point. Such an aërial is found to radiate least in its own plane.

Recently Kiebitz has performed some experiments with wires erected on poles only about three feet above the ground, and earthed at each end. Transmitting apparatus is joined to the centre of the wires, and, as in the case of the S. G. Brown earthed system, this arrangement radiates best in the direction of the wires.

There are many useful applications of these various directive systems.

The simplest is that of increasing the range of a station in a particular direction. In the case of land stations where the working is always with some other land station or always in a particular direction, directive aërials can be usefully employed. Inverted L-aërials are used for this reason at the large Marconi stations used for transatlantic working.

Another very important application of directive working is the taking of the bearings of one wireless station from another. When a ship is navigating near shore, her exact position is determined by observing the angles which lines drawn from the ship to two prominent points on shore make with the north direction, and then on the chart drawing lines through these two points making the observed angles with the north direction. The point where these lines cross is evidently the position of the ship.

This method cannot, of course, be employed in foggy weather, but if two wireless stations be on shore, and the ship have some means of ascertaining the direction from which the signals are received, the method described can be employed to obtain the position of the ship.

There are two distinct methods by which this may be done. The directive apparatus may be fitted on land, and the direction of the ship observed from the shore station, and communicated to the ship by wireless, or the ship may be provided with means for taking the observations herself.

Marconi applied his inverted L-aërials to a system in which the first method was used. A number of these directive aërials were erected on shore, radiating at equal angular distances from a centre. By means of a switch the apparatus could be joined to any one of the aërials, and therefore the aërial upon which the maximum strength of signals was obtained from the ship could be found. The direction of the ship was then opposite to that in which this particular aërial pointed.

Of course the necessity of erecting a number of aërials pointing in different directions could be avoided by erecting a single aërial, and providing means by which it could be turned into any desired

Digitized by Google

position. But such an arrangement would be very clumsy, to say the least. Bellini and Tosi have, however, devised an arrangement by which a resultant aërial, so to speak, can be rotated, while the actual aërial system remains fixed.

Two of the double aërials already described are erected with their planes bisecting one another at right angles. Each aërial has the secondary coil of an oscillation transformer joined in the connecting wire across the base, with their axes arranged at right angles to one another. These coils are wound on open frames. A single primary coil only is used, which is placed in the space inside the secondary coils, and which can be rotated about a vertical axis. If transmitting apparatus be joined to the primary coil, the resultant radiation will be in the plane in which the axis of the coil lies. By substituting receiving for transmitting apparatus, the maximum strength of signals is received when the inner coil is turned so that its axis points in the direction in which the signals are being received.

As with the Marconi radiating aërials, the bearings of ships can be observed from the shore station, fitted as described, and the information communicated to the ships by wireless.

The Telefunken Company have devised an arrangement by which the ship can herself observe the bearings. On shore sixteen directive aërials of the type already described are erected in the direction of the points of the compass. A continuously rotating switch joins the transmitting apparatus successively to the various aërials. Immediately before the transmitting apparatus is joined to the N–S aërials it is joined to a non-directive aërial. The operator on the ship is provided with a stop-watch, the hand of which makes one revolution in the same time as the rotary switch makes one complete turn. When he hears the signal from the non-directive aërial he starts the watch, the hand of which then follows the movement of the switch. When the strength of signals falls to a minimum the watch is stopped. It will be remembered that the Telefunken directive aërial radiates least in its own plane, and therefore the minimum sound occurs when signals are being sent on the aërial pointing towards the ship. The dial of the watch is marked with the points of the compass to which the aërials point which are joined to the corresponding contacts on the switch, and thus the bearing of the station from the ship is indicated by the hand of the watch.

The Marconi Company have recently devised a modification of the Bellini-Tosi system, in which the dimensions have been so much reduced that the aërials can be fitted on a ship.

Bearings can be taken to within two degrees, and at the same time the reduction in the size of the aërials has not been obtained at the cost of the sensibility of the arrangement. During some

Digitized by Google

experiments recently carried out on a ship between Folkestone and Boulogne, signals were occasionally received from ships in the Mediterranean Sea.

To provide points from which bearings may be taken, the French Government are building wireless lighthouses, or "radiophares," round the French coasts. These installations will be in continuous operation, and each radiophare will emit a distinct signal which will distinguish it from other similar installations. The wave-length and power used have been so chosen that these continuously working radiophares will not interfere with commercial wireless stations.

Another useful application of directive arrangements has been made in the Marconi duplex system.

Two stations, one for transmitting and one for receiving, are provided at each end, each fitted with inverted L-aërials. The receiving station is also provided with an additional directive aërial known as a balancing aërial, so placed as to pick up signals from the transmitting station. A receiving transformer having two primary coils, one joined to each aërial, is used, and arrangements are made that the effects produced in the aërials of the receiving station by the signals from the corresponding transmitting station neutralise one another. The signals from the distant point, however, affect the main receiving aërial more strongly than they do the balancing aërial, and thus the detector is actuated.

ALTERNATE CURRENT MEASUREMENTS, WITH SPECIAL REFERENCE TO CABLES, LOADING COILS, AND THE CONSTRUCTION OF NON-REACTIVE RESISTANCES.

Abstract of a paper read before the Metropolitan Centre by C. E. HAY, *on November 11th,* 1912.

SHORTLY after the invention of the telephone, many physicists entered into profound mathematical investigations of the electrical phenomena of the telephone circuit, and during the last twenty-five years there has been no lack of able theoretical work done upon the subject.

The speaking efficiency of circuits is being substantially improved, and recent achievements in the extension of the range of speaking bear eloquent testimony to the fact that progress continues to develop at a sure and rapid rate; so much so, that in the present state of the science he would be a rash individual who would predict a limit to the possibilities of the telephone.

Digitized by Google

Although a considerable amount of laborious work has been done in this country and abroad in the measurement of the physical quantities met with in the telephone circuit, yet it must be admitted that a vast amount of research involving precise determinations remains to be undertaken.

The paper describes methods devised and found successful in solving a few of the problems in alternating current measurements, to indicate where errors may creep in and to suggest means of overcoming them.

Methods based upon the principle of the Wheatstone bridge produce in general the most convenient arrangements combined with reliability and sensitivity, and all the methods described are based on this principle. Most of them are original so far as the author is aware, and in these cases detailed particulars and proofs of the theory are given.

METHODS OF MEASURING THE FREQUENCY.—Two methods of measuring the frequency of the alternations are employed in the Post Office laboratory, and these are the survivals of several which have been tried from time to time.

The first of the methods described is an electrically controlled automatic speed counter.

The instrument is coupled direct to the high-frequency alternator, its spindle being geared to the counting mechanism by means of a worm and wheel having a ratio of 1 to 200. The counting mechanism is kept revolving continuously, but an indicator rigidly fixed to an iron disc, capable of revolving in front of a rotating electro-magnet, is actuated automatically by means of a pendulum, which, operating a pawl and counting wheel, closes the electric contact once each minute.

The second instrument is called "the instantaneous frequency indicator." The method depends upon the principle of the Lorenz apparatus. A copper disc, coupled direct to the spindle of the alternator, is caused to rotate in a magnetic field at the same armature speed as the machine. The instrument is so designed that when a convenient current is flowing through its winding, a pressure of one millivolt is generated between the centre and circumference of the copper disc when it is rotating at a speed of 2000 revolutions per minute. This voltage is balanced by the drop of voltage in a slide wire, through which the same current is flowing as that in the winding, and balance is indicated on a sensitive reflecting galvanometer of low resistance. The voltage generated in the rotating copper disc is directly proportional to the number of revolutions per second, being equal to the number of revolutions multiplied into the mutual inductance between the winding and the copper disc. If, therefore, the slide wire is calibrated in terms

Digitized by Google

of revolutions per second or frequency, the instantaneous value of the frequency may be read direct, by simply bringing the reflecting galvanometer to zero by moving the slider.

A METHOD OF MEASURING THE CHARACTERISTIC IMPEDANCE AND ATTENUATION CONSTANT OF CABLES.—In the present state of the theory of telephone transmission in cable circuits it is highly desirable that precise measurements should be made in order to secure quantitative data for comparison with theory, and to furnish a foundation upon which future progress must rest. The standard cable is strictly limited to qualitative comparison, and to extend its use to quantitative measurements is illegitimate. The most important quantities which it is required to know in connection with telephone circuits are the characteristic impedance and the attenuation constant. The author describes in detail a method of measuring the open and the closed impedance with apparatus available in any well-equipped laboratory. A non-reactive resistance, two non-reactive adjustable rheostats, two adjustable mica condensers, a non-reactive slide resistance, and an air-condenser are employed in the test. The method was explained in detail by means of diagrams, and a mathematical proof was given. Very accurate results have been obtained by the use of this method.

NON-REACTIVE RESISTANCES.—It is essential, in making accurate measurements with alternating current at frequencies ranging up to several thousand periods per second, that the resistance should be free from residual inductance or capacity. The author announced that, after two years' experimenting, he had discovered a method of constructing resistance coils remarkably free from residual self-inductance or capacity, and equal in accuracy to the highest precision D.C. coils.

Results were quoted which had been confirmed by the National Physical Laboratory in support of Mr. Hay's statement.

MEASUREMENT OF SMALL INDUCTANCES AND CAPACITIES.—In the measurement of the very small residual self-inductances possessed by resistance coils constructed with a view of being entirely non-reactive, the author has found the simple Maxwell method and the modification of it by Professor Anderson to give excellent results.

Some idea of the nature of the problem of measuring self-inductance of a few centimetres may be formed when it is considered that a self-inductance of one centimetre bears the same relation to the self-inductance of a loading coil as the length of a lead-pencil bears to the diameter of the earth.

LOADING COILS.—The measurement of effective self-inductance of loading coils at telephonic frequencies is a comparatively easy matter, but to measure the effective resistance with any degree of accuracy is a somewhat difficult problem.

Digitized by Google

The author referred to Mr. Pollock's method of wiping out entirely the reactance of the loading coil by means of capacity joined in series, and allusion was made to a method introduced some time ago by the author for the measurement of effective resistance, which may be directly determined to a degree of accuracy within 1 per cent.

The standard frequency at which loading coils are measured is 1780 periods per second and the standard current 0·8 milliampère. The reason for the adoption of these values is difficult to understand, and the author suggested that the standard frequency be altered to 1600 periods per second, and the standard current to one milliampère.

ALTERNATIVE METHOD OF MEASURING CAPACITY, LEAKANCE, SELF-INDUCTANCE AND EFFECTIVE RESISTANCE BY MEANS OF A MUTUAL INDUCTANCE.—The connections of an arrangement devised by the author for an alternative method of measuring the above were shown, and it was claimed that the method possesses the advantage that when balance is obtained it is independent of the resistance, self-inductance and capacity of the mutual inductance windings.

In conclusion, Mr. Hay paid a tribute of thanks to Mr. H. R. Kempe for his kind assistance and encouragement, and also expressed indebtedness to Mr. Pollock for the unique high-frequency alternator, without which little of the work described in the paper could have been undertaken.

A very useful series of appendices accompany the paper, giving diagrams of connections for the various tests described, also mathematical proofs of all the formulæ introduced.

"CORRECT TIME."

Abstract of a paper read before the Metropolitan Centre by R. MYLES HOOK, *on October 14th*, 1912.

THE author dealt with the history of time indicators from the early ages, giving an epitome of the various devices used from the days of Job, who, it may be interesting to note, suggested the measurement of time by the length of a shadow.

The Babylonian "parasang" was referred to—a measure of distance from which was derived the division of the day into hours. The sun-dial as we know it dates from about 540 B.C. It is on record that the Romans captured a form of sun-dial in the year 290 B.C., and had it set up publicly in Rome.

The first water clock was constructed in 135 B.C., and this,

Digitized by Google

together with sand clocks and similar devices, inaugurated the advent of time-keeping *machines.*

The different kinds of time were next explained—*solar time,* which is the time indicated on a properly set up sun-dial; *mean solar time,* by which the variations in solar time, due to the ellipticity of the earth's orbit, are eliminated; *sidereal time,* being, as its name implies, star time; and *local time.* The advent of railways and improved methods of communication practically led to the abolition of local time, and the world is now divided into time zones, in which the mean solar time on one meridian, generally reckoned as an integral number of hours from Greenwich, is adopted as *standard time.*

Since 1852 the Post Office has received an hourly signal transmitted automatically from the mean solar clock at Greenwich Observatory, and at ten o'clock every morning that signal was transmitted by telegraph to every telegraph office throughout the kingdom, all the clocks being then reset by hand, which is still done at nine a.m. daily. To provide watch and clock makers with a daily time signal, automatically transmitted and sufficiently accurate to meet their requirements, an instrument called the chronopher was designed by Mr. C. F. Varley. This was of the nature of a multiple change-over switch, operated by means of a spring motor, released by an electrical contact on a clock. The chronopher, as installed in those early days, is still doing useful service, but has become much overloaded. The temporary disturbance of the telegraph wires has also resulted in such inconvenience to telegraph traffic that it has now become necessary to introduce a new system.

The hourly signal continues to be transmitted from the mean solar clock at Greenwich Observatory to the Central Telegraph Office in London, where it is received upon a main relay forming part of the new chronopher apparatus. The local side of this main relay operates the other relays which transmit the hourly signal to London renters, and ring bells, etc., fixed in various administrative and operative departments of the group of buildings associated with the General Post Office headquarters.

Certain provincial offices have been chosen as sub-chronopher stations, and their circuits, regarded as main distribution circuits, are connected to the tongues of groups of switching relays which normally retain these circuits in connection with their telegraph apparatus, but which, when operated by control circuits from a special electrical clock, transfer the telegraph circuits from the telegraph apparatus, and bunch them on the tongue of a transmitting relay, so that a positive current, which forms a preliminary or warning signal, is sent out on all distribution lines. On the receipt of the Greenwich signal, the operation of the main relay causes the transmitting relays to reverse the current on the lines momentarily,

Digitized by Google

the reversal constituting the distributed time signal. At the provincial offices similar apparatus, but on a smaller scale, is installed for secondary distribution over other circuits radiating therefrom to individual offices, wherein hand-operated switches control the arrangement of the local circuits for transmitting the signal to subscribers' premises.

Distribution to the provinces takes place at ten and one o'clock, and at the provincial sub-chronopher stations the switching relays are joined in groups for the ten o'clock, one o'clock, or both signals, according to the service required in any particular town. The controlling clocks are set so as to operate the switching relays from one and a half minutes before to one and a half minutes after the hours. The whole of the country is thus divided into convenient districts from the centre of which any town therein may obtain the time signal automatically and without inconvenience. This scheme is, of course, extremely elastic, and will enable growth to take place unhampered by considerations regarding the use of long and expensive telegraph wires. Instead of having upwards of 200 such circuits radiating from London as heretofore, only about twenty are required with the new system.

The majority of the methods for zeroising clocks by means of a synchronising current in use at the present time depend upon the action of a lever or roller caused to come into contact with, and push round, a spiral cam or its equivalent. With certain restrictions this method is reasonably good.

When it was decided that the Post Office should consider the question of automatic correction from a practical point of view, the methods previously in use were very carefully analysed, and, after experimenting at some length, the Department arrived at several rather important conclusions, amongst others that the periodic checking of a gaining rate was fundamentally correct, because of the backlash that must perforce exist in any train of wheels, whereby any attempt to move a slow clock forward would disengage the teeth of the train from their driving position, which space would afterwards have to be gathered up when the correcting power ceased to apply, obviously leaving the clock incorrect to the extent of such backlash. This, of course, does not occur when setting back or checking a gain is concerned, for the engagement of the teeth of the train is not disturbed. An important desideratum recognised was that whatever might be the method adopted, the additional part or parts to be added to a clock must be of such design as to be readily incorporated in all the classes of clock in use in the Post Office from 10-in. timepieces up to comparatively large 36-in. dial clocks, and, above all, the cost of the apparatus and fixing it must be reasonably low.

Digitized by Google

A small electro-magnet detent was therefore designed, which can be readily attached behind the dial of any timepiece, and which, when equipped with a pair of terminals, fixed to a clock and included in an electrical circuit having a suitable hourly signal thereon, is all that is required to enable an erratic timekeeper to be converted into one whose performance may be relied upon implicitly within an error limit of a fraction of a minute. The electrical resistance of the synchronisers used on Post Office installations is 10 ohms, and all the clocks in a building are connected in series or in series-parallel groups, the voltage at the master clock being regulated so as to afford a current value of about 250 milliampères in each circuit, whatever be the number of clocks. Synchronisation is, of course, but a compromise, and the ideal system for a synchronous time service may be achieved by the use of such simple and inexpensive mechanisms as the modern electrically propelled clocks, driven by electrical impulses from one master clock.

So far as the Post Office itself is concerned, where the equipment of a new building or one hitherto not adequately provided with clocks is in question, a purely electric system should invariably be installed whose master would be automatically synchronised. H.M. Office of Works have equipped many buildings, including post offices, with the Magneta clock system. They have not, however, gone so far as to arrange for the automatic control of the master clocks, preferring apparently to rely upon the personal correction made, if necessary, when the master clocks are manually wound up daily, as is necessary with the Magneta system.

There are many systems of electric clocks now available, each system claimed as better for time-keeping than the others, but premising daily synchronisation by a Greenwich signal, exact time-keeping qualities are really not of prime importance, and in the author's opinion an ideal system should consist of a master clock, which should be entirely independent of personal attention for winding or correction, lending itself readily to automatic correction, and connected to secondary clocks in which the moving parts should be as few as possible and coupled with driving mechanism of the rotary type—akin to an ordinary electric motor. In 1896, when the Post Office acquired the telephone trunk wires, the need arose for large clocks indicating periods of ¼ minute, and those which were then made in accordance with the design of Mr. Kempe were operated by rotary armatures. These clocks, made more than fifteen years ago, are still in use and are doing their work satisfactorily, much more so than if they had been driven by ratchet work, which would have involved some measure of adjustment to take up wear, and more or less variable springs which are almost inseparable from

Digitized by Google

that type of gear. These particular clocks, designed a long time before the electric clock industry had reached its present stage of perfection, are rather unique, inasmuch as the third concentric hand revolved once a minute in four jumps of a quarter of a revolution each ¼ minute, involving a little mechanical problem not quite easy of accomplishment. The clocks were made in two sizes with 24-in. and 5-in. dials, similar driving mechanism being employed in each size. Their functions are now, however, being performed by calculagraphs and time checks.

We now have the benefit of the radio-telegraph stations on the Eiffel Tower and at the mouth of the Elbe transmitting time signals for the benefit of all who have means for listening to them. The cost of the apparatus necessary for the reception of these signals on ships unprovided with radio-telegraph apparatus is from £10 to £20—not a large sum when compared with the immense value of the service thus obtained; and aërials having an elevation of 20 m. are sufficient for vessels within a radius of about 200 miles. The author referred to the immense value afforded by radio time signals in surveying operations, for, by this means, most minute differences in longitude can be calculated.

BOOKS IN OUR LIBRARY.

'Hints on the Conduct of Business—Public and Private.' By Sir Courtenay Boyle, K.C.B. Publishers: Messrs. Macmillan.

The infusion of so much new blood at one time into our Department led inevitably to much comparison and discussion on the subject of "our ways" and "your ways" between the "pre's" and "ex's," and there has been much healthy discussion on methods of conducting business, all of which has undoubtedly been to the good, and in some cases has no doubt resulted in the adoption of suggestions which will bring about desirable improvements. One subject which has been specially attacked by the more fiery of the new combatants has been the Civil Service method of conducting correspondence; I mean the method of keeping all the papers on a given subject together in regular order arranged in consecutives files, and sending these backwards and forwards between the persons concerned in the negotiations, without special regard to the ever-increasing bulk of the papers which have to be handled. When compared with the ordinary commercial method in which correspondents retain letters received and keep carbon or press copies of letters sent, so that each party is always in possession of a complete file of the correspondence, the Service method seemed to be specially vulnerable. So far, however, it has survived any suggestions which may have

Digitized by Google

been made for its modification, and it can, of course, be argued strongly that it has special advantages in the case where correspondence is not merely between two parties but between many parties, each of whom wishes to know all the ideas and opinions of those who have handled the subject before the papers reached him. The frequency of these discussions has caused my mind to recur to the excellent book referred to above which was acquired by our library soon after its opening, and has no doubt already been read with pleasure by many members of the Institution. It seems to me that there can be no more suitable time than the present to give a few quotations from its interesting pages. At the outset Sir Courtenay deplores the fact that in the most businesslike community in the world the idea should prevail that habits of business and methods of doing business can be learned by actual practice only, and that little or no attempt is made at precept, and after quoting a similar statement made by Bacon three centuries ago, he sets out to repair the omission. On the subject of the education of young people who hope to get into the Civil Service, he states for the information of parents:

"The Civil Service is divided into two grades, and though efforts are continually being made to blur the line dividing them, it is still tolerably clear. The preliminary training, therefore, desirable in the case of the young man who aspires to the higher grade differs from that desirable for entry into the lower division. But, even as regards the higher division, I have long thought that advantage would accrue were more attention bestowed by teachers at schools, at universities, and at other training establishments, to matters connected with business. As head of a department or of a branch of a department, I have frequently been brought into contact with clerks who, having taken high degrees at a University, or otherwise acquired attainments of scholarship of no mean order, have been incapable of carrying out their work in an office without being taught rudimentary rules; and who have been utterly without grasp of simple ideas which might well have been inculcated before instead of after their assumption of duty."

For the information and encouragement of lower division entrants we have the inevitable reference to the Field Marshal's baton:

"As every soldier entering the army is supposed to carry a possible field-marshal's baton, so every boy entering the service ought to have the pen of a possible head of department. There are instances of rise from the lowest to the highest rank in the Civil Service as in other professions, and of the office-boy becoming the head of a huge commercial house. But the preliminary training of our great middle-class schools must be based on the principle that such instances are exceptional. Meanwhile it should be understood more widely than appears to be the case that for recruits in the lower ranks of the army of business the following qualifications are desirable: A knowledge of shorthand; a thorough capacity for sending and receiving telegrams; an

Digitized by Google

acquaintance with the Morse code. Book-keeping up to at least the preparation of a profit and loss account and a balance sheet. Some acquaintance with commercial arithmetic, more with commercial geography. The elementary principles of criminal and commercial law. The elements of economics, up to at least some understanding of mediums of exchange. And lastly a power, so far as it can be taught, of writing plain and simple English, of making epitomes or *resumés* of papers, and of detecting errors in documents submitted for examination."

Three chapters are devoted to the subject of notes, on which Sir Courtenay has much of interest to say, and here, as throughout the book, one cannot help being impressed by the excellent English in which the ideas of the writer are expressed. On the subject of signatures, for instance, he is very definite, and all who have suffered —and who has not—from scarcely legible signatures will be in sympathy with the following paragraph:

"A signature should be as clearly written as possible. There is a great temptation at the end of a note or even letter to dash off a signature in a hurry. This may be due to a feeling of relief at reaching the end of a bit of work, or to a feeling of assurance that the reader will not be puzzled. Or it may again arise from a desire for bold caligraphy. In autograph books how many fewer signatures are there carefully and clearly written than impetuously and courageously scrawled? Bad hand-writing is mischievous anywhere. In a signature it is especially so. An ill-written signature is sure sooner or later to get its writer into trouble. Some sorely needed answer will miscarry, or some important negotiation go wrong, because someone, not necessarily he or she to whom the letter is addressed, will fail properly to decipher the signature."

But we cannot help thinking that he finishes with what is surely a counsel of perfection, thus:

". . . . With most surnames it is desirable to combine not merely an initial but a Christian name written in full. A leader of the House of Commons is perfectly justified in habitually signing his surname after two initial letters only. Persons less well known had better sign more fully."

Then as to dates:

"All notes as well as all letters should be dated. To this rule there is no exception. Even an invitation to dinner, tea, or a drive, should be prefaced by the date on which it is issued, and the place from which it is sent. The day of the week alone will not do. Many women, and *not* a few men, date notes which they think of little importance Monday or Thursday simply. The result is that if the note miscarries and is delayed, difficulty is bound to occur. 'Will you come and dine with me to-morrow? Yours sincerely, Dick. Tuesday.' For some reason Tom does not receive this till the week after that in which it was written. He does not look at the postmark on the envelope, and dashes off a reply in the affirmative which in its turn is not received.

Digitized by Google

Tom will probably have to dine at his club. It is no more trouble in the outset, and causes far less trouble in the long run, to write 'August 29, '99,' than to write 'Tuesday.'"

Ambiguity as to place is to be avoided quite as much as ambiguity of date, and this precept is expressed by the following story of a visit to Dollis Hill by Archbishop Benson:

"One summer the late Archbishop of Canterbury and his wife were invited to dinner by Mr. and Mrs. Gladstone, who were then staying partly at Dollis Hill and partly at Carlton House Terrace. Mrs. Gladstone wrote on Dollis Hill paper, but forgot to localise the dinner. When the evening came, the Gladstones were ready and waiting for the Archbishop at Carlton House Terrace, but no Archbishop arrived. Mr. Gladstone, who was, above all things, punctual, had his patience sorely tried, and after waiting till 9 p.m. declared, 'I wouldn't do this for any man but an Archbishop.' Eventually the Bensons arrived, having driven all the way to Dollis Hill and back."

In any other year but this it might have given us pain to find our own particular Department held up to objurgation. We extract the following story without comment:

"When I was private secretary in Dublin I received a lithographed form from the post office demanding payment for a long telegram addressed to the Viceregal Lodge on the previous day. As I expected to see the Secretary of the post office in a few hours I put the demand note in my basket of papers in action. Next morning I received a more peremptory form, and on the same day a third form, also lithographed, saying that if payment were not effected at once reference would be made to the sender of the telegram. I despatched a semi-official express to the head of the post office pointing out that the telegram was on important public business, the recipient the Lord Lieutenant of Ireland, and the sender the Queen."

Some of the best paragraphs in the book deal with the subject of language, and for the benefit of some who have found that there is a somewhat elusive kind of difference between commercial English and Civil Service English we quote further, thus:

" . . Language should be kept in check. Strong language in the ordinary sense of the term far more often betrays weakness than shows power. Strong language should be carefully eschewed. So much so is this the case that the tendency of words chosen for their inoffensiveness is to gain and gather force. Such epithets as 'ill-considered' or 'ill-advised,' selected originally because of explicit limitation of force, have now grown almost too forcible to be used. Even if two ladies hold an angry correspondence with each other on a purely social subject she will emerge with most credit who most successfully keeps her phrases under control, and this is so with official correspondence. It is out of the question to write that such and such a public body has behaved, or proposes to behave, idiotically or even foolishly. It is unwise to say that its action is ill-considered. It is at most permissible

Digitized by Google

to say that My Lords, or whoever are the criticising body, 'are unable to consider that the action contemplated by —— is likely to promote the interests which presumably they have at heart.' And even such a phrase errs on the side of vehemence.

"A somewhat amusing instance of due appreciation of the value of reticence once came under my notice. Two officers of a department under my care having had a personal dispute set to work to quarrel on paper, and their observations were brought to me. In them Mr. A— said of his opponent, 'Mr. B— failed to appreciate the force and the energy, the justifiable force and energy, of the language which I kept back.'"

Some good counsel is given on the subject of deputations, councils and conferences, and we are reminded of Polonius and Laertes' example—

> "Give every man thine ear, but few thy voice;
> Take each man's censure, but reserve thy judgment."

The last chapter deals with adroitness and cunning, and although cunning of the ordinary kind is condemned, and properly condemned, the admonition does not seem to be sufficiently strong and definite to be in accord with the high standard of conduct recommended elsewhere throughout the book. The position is, however, somewhat altered by the concluding lines, as thus: "Cunning is not wisdom. Stratagem is a poor form of skill. An upright business man is most likely to succeed who adopts the position of Juliet:

> 'But trust me, gentleman, I'll prove more true
> Than those that have more cunning to be strange.'"

There is much of value with regard to other subjects which I have not been able to touch upon, but, as on previous occasions, my main object is to whet the appetite of my readers in the hope that more frequent demands may be made upon our Librarian for the loan of good books which at present are not frequently called upon.

D. H. K.

A NEW BOOK ON WAYLEAVES.

THE issue of a new book on wayleaves at the beginning of October, when the Engineering Department of the British Post Office had just taken over the maintenance of the ex-National Telephone Company's plant, was not a mere coincidence. This book was, in fact, largely designed to facilitate the wayleave portion of the work.

It may be well to outline the principal wayleave difficulties which

Digitized by Google

arise out of the transfer of the late National Telephone Company's undertaking to the Post Office.

(*a*) The ordinary routine work has been more than doubled.

(*b*) All public and railway wayleaves must be revised in accordance with the powers possessed by the Post Office under the various acts and agreements.

(*c*) Private wayleaves considered to be unduly expensive, or in respect of which the Postmaster-General could put into operation certain powers (*e.g.* cases of flying wires), also need revision.

(*d*) Telephone services granted free or at reduced rentals by the late company in return for wayleaves are being charged for by the Post Office at tariff rates, thus necessitating the negotiation of fresh wayleave consents under trying conditions.

It is obvious that this work can be grappled with efficiently only by a staff having a knowledge of Post Office methods and powers, and the book on wayleaves is designed to supply that knowledge. Prior to its issue, the official works of reference on the subject were:

(*a*) Section VIII of Engineering Regulations.

(*b*) Wayleave Instructions.

(*c*) Instruction dealing with the erection of telegraphs on railways and canals.

(*d*) Sir Robert Hunter's memorandum on the powers of the Postmaster-General with reference to the construction and maintenance of telegraphs.

(*e*) Copies of the Telegraph Acts.

Of these the first two only were easily accessible, the remainder being distributed in very small numbers. Moreover, the existence of several books led to duplications and sometimes gave rise to discrepancies. Further, only the first two books possessed machinery for the issue of amendments, which are unfortunately necessary even in the best regulated Departments.

Under the circumstances, rather than reprint the existing works of reference separately, it was decided to amalgamate them in one book arranged on a definite basis and with all duplications and discrepancies deleted. Special efforts have been made to provide a satisfactory and full index. Two thousand copies of the book have been printed so that all concerned may consult it. It will be kept up-to-date by the issue of monthly amendments. The actual arrangement of the book is described in an introductory note, which it is scarcely necessary to recapitulate.

There is perhaps one thing required to complete the happiness of those who deal frequently with the subject, and that is a really good map designed to illustrate the Postmaster-General's rights on railways and canals. There can be no doubt that a map, preferably in colours, but at all events with each section of railway and canal

Digitized by Google

numbered and indexed to show the wayleave and maintenance position, free conveyance privileges, conditions governing alterations of telegraphs, etc., would be very useful. However, this is a minor matter, which will doubtless be put right before the next edition of the book is needed. P. W. T.

NEW BOOKS.

'C.B. Telephony Simplified, a Book for Practical Telephone Men and Students,' by Walter Atkins, Engineering Department, G.P.O. ('Electrician' Printing and Publishing Co., Salisbury Court, Fleet Street, E.C. Price 3s.)

Mr. Atkins, who has had considerable experience in connection with the maintenance of C.B. Telephone Exchanges, has produced a book which is, as he says, essentially for the practical telephone man. It does not deal with the history or the science of telephony, nor with obsolete systems, but, assuming a knowledge of the fundamental principles of electricity, it proceeds to analyse the various circuit arrangements which make up that complex organism, a common battery exchange. Wiring diagrams are not given, but great care, much labour, and some ingenuity has been exercised to produce simplified diagrams which serve well for the purpose of conveying to the aforesaid practical man or student a clear conception of the working arrangements. While these diagrams are very well done, it may be pointed out that the draughtsman has followed the bad old practice of drawing all the lines with sharp right-angle corners. Recently it has come to be realised that diagrams with round corners are much more easily followed than the right-angled variety. Opticians tell us that the eye halts at every obstruction, and, indeed, it is easy to show by experiment that a nicely rounded curve is just as helpful to the eye in the matter of "keeping on the line" as it is to a railway train. It is perhaps somewhat regrettable that, writing as he does for test-room men, the language adopted is in some cases what may be called test-room English, but this will not in any sense reduce the usefulness of the book, and, in some senses, may actually enhance it. Without being hypercritical, one may perhaps point out that Mr. Atkins has occasionally lapsed into the pre-transfer habit of referring to "pegs and cords" where "plugs and cords" are meant. The book will be fully entitled to a place on the shelves of the rapidly increasing number of persons who are interested in the maintenance and construction of C.B. Telephone Exchanges.

Digitized by Google

'The Practical Telephone Handbook and Guide to the Telephone Exchange,' by J. Poole, A.M.I.E.E., Whitworth Scholar, Technical Staff, British Post Office Telephones. Fifth edition, revised and enlarged. (Whittaker & Co., Paternoster Square, London, E.C. 6*s.* net.)

It says much for the success and popularity of Mr. Poole's book that it should have already reached its fifth edition, and it is clear from the additional matter which has been added that he is sparing no pains to keep it abreast of the times. The new edition includes a description of the Avenue Exchange, additions to the theory of artificial lines, and the statistical tables referring to telephone development in the United Kingdom, Europe, and America.

The tables are of considerable value and have been brought up to date.

The frontispiece is a picture of Dr. Alexander Graham Bell, who is still alive, and recently took part in Chicago in a function for the purpose of celebrating the enormous development of his 1876 invention. It is unfortunate that the reproduction of the portrait has not been very well done.

For telephone students, both from the point of view of excellence and price, Mr. Poole's book is without a rival.

' Practical Electrician's Pocket Book and Diary, 1913.' (Rentell, cloth 1*s.* net; Rexine [with insurance], 1*s.* 6*d.* net.)

In ' The Practical Electrician's Pocket Book ' for 1913, certain standard and well-understood chapters have been omitted or materially condensed, while new matter has been added in the shape of sections dealing with electric coal-cutting machines, the safe sizes of cable to use for electric lighting, the average errors of commercial electrical instruments, electric power requirements, power factor meters, the control of lighting circuits, wireless stations of the world, the new Home Office mining rules, etc., thus increasing the size of the book by about 44 pages. The printing and binding are alike excellent, and the book can be safely recommended as a thoroughly reliable *vade mecum* of real value to the practical man.

' Measurement of Induction Shocks,' by E. G. Martin. (Chapman & Hall, Ltd., 11, Henrietta St., W.C.)

' Wireless Telegraphy and Telephony,' by W. J. White. (Whittaker & Co., 2, White Hart Street, Paternoster Square, E.C. Price 2*s.* 6*d.*)

'Toll Telephone Practice,' by J. B. Thiess, B.S., and G. A. Joy, B. E. (Constable & Co., Ltd., 11, Orange Street, Leicester Square, W.C. Price 14*s.*)

A detailed description of American Trunk Practice.

Digitized by Google

ERRATA.

In Mr. G. F. Mansbridge's article, "Desiccation of Paper-Insulated Cables," page 307, vol. V, part 3, the formulæ have been mutilated in the press and the following should be substituted:

From the results obtained it became possible to deduce the laws connecting—
Pressure and current (with length constant),
Length and current (with pressure constant),
Current and pressure (with length varied).

It was found that these laws differ altogether from those governing the flow of air in pipes having little obstruction, such as pneumatic tubes.

To take first the relations between pressure and flux. These are:

In a pneumatic tube, flux $\propto \sqrt{P}$

In a tightly packed cable, flux $\propto \sqrt{P^3}$

or, expressing the same thing in terms of resistance, the relation becomes—

In a pneumatic tube, resistance varies *directly* as $\sqrt{P}$

In a tightly packed cable, resistance varies *inversely* as $\sqrt{P}$

Taking next the relations between flux and length, these are:

In a pneumatic tube, flux $\propto \frac{1}{L^{\cdot 5}}$

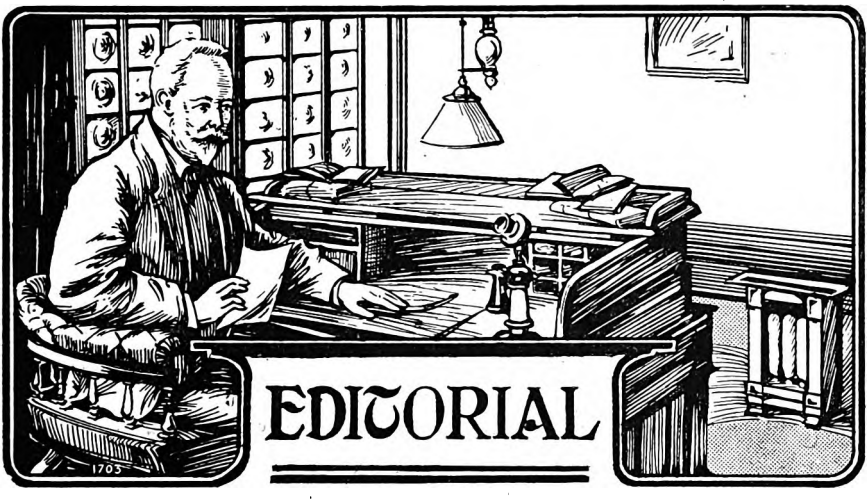
In a tightly packed cable, flux $\propto \frac{1}{L^{1\cdot 1}}$

Combining these relations we get the following:

In a pneumatic tube, flux $\propto \frac{P^{\cdot 5}}{L^{\cdot 5}}$ or $\sqrt{\frac{P}{L}}$

In a tightly packed cable, flux $\propto \frac{P^{1\cdot 5}}{L^{1\cdot 1}}$ or $\frac{\sqrt{P^3}}{L^{1\cdot 1}}$

Digitized by Google



Ancillary Jacks *versus* Aid-plugs.

Those of our readers who make a study of the development of specialised methods of handling telephone traffic will remember that the first part of the present volume of this Journal contained a description of the new Avenue Exchange, in which, for the first time in this country, the subscribers' exchange lines were provided with ancillary jacks. The object of this provision is, of course, to enable the available staff to be brought to bear on traffic rushes with greater flexibility.

Although other exchanges in London have been similarly equipped, the ancillary system is still on its trial. While its theoretical advantages are somewhat attractive in practice, it involves considerable waste of effort on the part of operators who, when about to answer a call, find that they have been outstripped by a more alert colleague, and, on the other hand, the fact that nine operators are available to answer a call offers such inducements to shirkers that good results can only be obtained by putting a heavy strain on supervision. The opening article of this issue, by our able contributor, Mr. P. V. Christensen, describes the method which has been adopted by the Copenhagen Telephone Company under similar circumstances to those referred to above.

Instead of providing the subscribers' lines with additional jacks, the Copenhagen operators are provided with additional "aid-plugs," which are only brought into use to meet over-load rushes, and by means of which an overloaded operator can, with a minimum of effort, transfer some of her work to one who is disengaged.

Normally the operators work under ordinary C.B. non-ancillary

Digitized by Google

conditions, and the system is, therefore, free from the objections we have referred to above.

From Mr. Christensen's point of view further features of comparison may be summarised as follows:

(1) The cost of the aid-system is about £12 per position, while the corresponding cost of ancillary jacks is about £35.

(2) The aid-system requires less space in the boards than the ancillary system, which is of importance where there is a large multiple field.

(3) Old exchanges may, without difficulty, be arranged for the aid-system and thereby have their existence prolonged and their efficiency increased.

The claims of the alternative systems offer a nice field for traffic research, and we should be glad if partisans on either side would favour us with their views for the information of our readers.

Death of Charles Borseul.

The Paris newspapers of Sunday, November 24th, 1912, gave publicity to the fact that there had just died in that city, at the age of eighty-three, poor and unknown, Charles Borseul, the first discoverer of the principle of the telephone. Borseul, who was the son of a French officer, was a student of telegraphy, and in 1854 propounded the theory of the telephone. It is stated that he obtained the consent of his chiefs before publishing his discovery, but the permission was accompanied by a warning that he had better devote his attention to more serious matters.

Borseul's claim to the distinction of having enunciated the principle was recognised thirty years ago by Dr. Graham Bell and Mr. Edison, and many of our readers who, in their early days, pored over "Preece and Maier," and "Preece and Stubbs," will remember how these text-books reproduced the very words in which Borseul made his famous prediction.

Telephone Reorganisation.

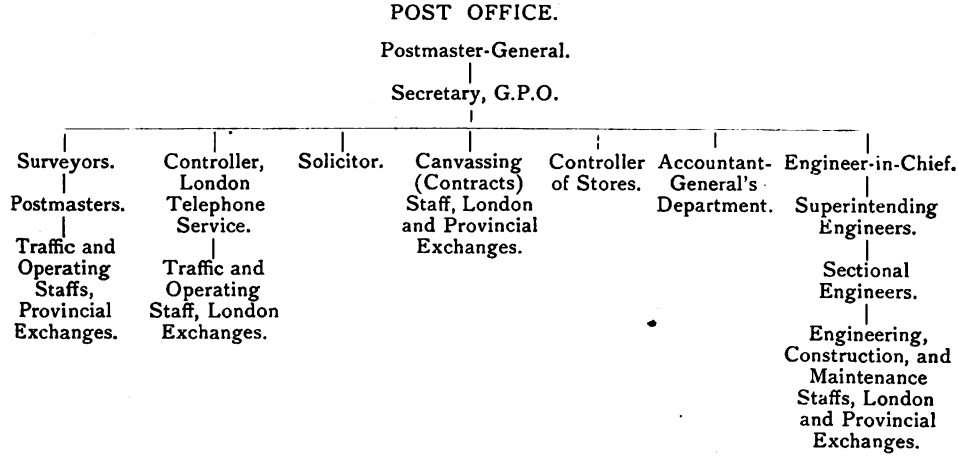
Even "the man in the street" knows that on January 1st, 1912, the Postmaster-General, who already administered an extensive telephone system, acquired the business of the National Telephone Company, and possibly he may be aware that the purchase price is still occupying the attention of the Railway Commission at the Royal Courts of Justice. But neither he, nor many other persons more directly interested, have any definite knowledge of the steps taken—after careful investigation by competent representatives of both the original undertakings—to modify the previous Post Office

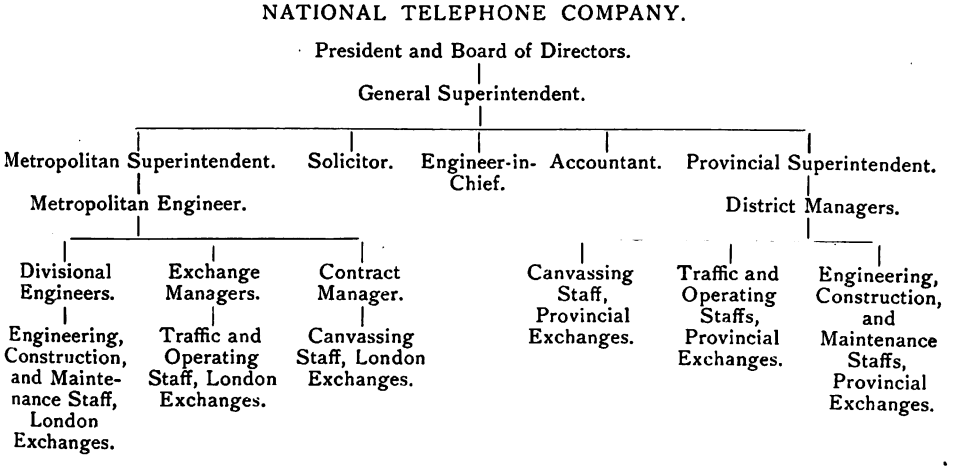
Digitized by Google

organisation so as to ensure the highest degree of efficiency for the combined telephone services of the country.

The organisation of the Post Office and that of the National Telephone Company differed fundamentally, and the difference may best be described by saying that in the Post Office the first division of work—*i. e.* between the various departments—was made on a functional basis, the separate departments being then organised independently on a territorial basis, whilst the National Telephone Company's organisation was primarily territorial, with some degree of functional administration at headquarters.

The following diagrams indicate, approximately, the arrangements:—





Thus, in the Post Office, the canvassing, operating and engineering staffs were controlled by three separate departments, whereas, under

Digitized by Google

the National Telephone Company's system, the whole of the staff was controlled in the provinces by the district managers, and in London by the metropolitan superintendent. (It may be remarked that the London organisation of the National Telephone Company was, until a few years ago, practically identical with that of the provincial districts, but experience dictated the advisability of the modification indicated by the diagram to meet the special conditions obtaining in the metropolitan area.)

At an early stage of the deliberations, prior to January 1st, 1912, one fact emerged very clearly—namely, that the fundamental difference between the two organisations rendered immediate fusion a practical impossibility, and that actual experience of the Company's business was necessary before any material changes could be made with safety. The actual changes which took effect on the acquisition of the business were, therefore, only such as were rendered inevitable by (*a*) the fact that the higher officials of the National Telephone Company did not enter the Post Office service, and (*b*) the desire on the part of the Postmaster-General to secure very close co-operation of the administrative staff during the re-organisation. These changes may be summarised briefly as follows:

Transfer of general administration to Secretary, General Post Office, involving transfer of legal, accounting and stores work respectively to Post Office Solicitor, Accountant General, and Controller of Stores, and of general oversight of engineering work to Engineer-in-Chief.

Transfer of London contract traffic and operating staffs to Controller, London Telephone Service.

Transfer of London and Glasgow engineering staffs to Post Office Superintending Engineers.

Reduction in number of provincial superintendents and assistant superintendents and transfer of remaining officers to headquarters (with exception of superintendent for Ireland).

It will be evident that the position of the district managers was practically unaffected, as they retained control of all ex-National Telephone Company's local work in the provinces, and the matters remaining in abeyance were consequently—

(*a*) The relations of surveyors, postmasters and district managers in regard to commercial and traffic matters, *i. e.* the negotiation and acceptance of agreements, control of operating staff and general supervision of telephone work, including arrangements to meet prospective development, and—

(*b*) The relations of district managers to the Engineer-in-Chief, superintending engineers and sectional engineers in regard to the construction and maintenance of engineering plant.

(Of course arrangements were made to secure uniform treatment

Digitized by Google

of certain matters, *e. g.* disciplinary cases, and to ensure co-operation between the various local officers in utilising existing plant to the best advantage and in preventing the provision of unnecessary plant.)

The first decision reached was that the principle already in operation of separating engineering work from traffic work should be extended to the new business, but it was evident that this course would involve material alterations either of the areas constituting the telephone districts controlled by the district managers, or of those constituting the sections controlled by Post Office engineers, if the resulting " loads " of the latter were to be even approximately equal.

The matter was further complicated by the fact that it was desired to maintain the National Telephone Company's practice of comparing the expenditure and revenue in each subdivision (or " centre ") of their system, as this implied coincident boundary lines for the engineering and traffic areas.

The question of delimitation was therefore referred to a small committee representing the departments chiefly concerned, and, after careful inquiry, it was found that the existing Post Office engineering " sections " afforded the most satisfactory basis, because, not only did each contain (like the district manager's divisions) one or more complete " trunk areas," *i. e.* complete units for the purpose of the local service, but their boundaries also satisfied the requirements of the telegraph and trunk telephone systems; further, the Post Office " sections " covered the whole of the country, whereas in many cases the National Telephone Company's districts were separated by gaps, sometimes of considerable magnitude, in which there was no telephone plant other than that of the Post Office. To effect the objects in view, however, certain re-arrangements proved to be necessary, *e. g.*, the amalgamation of some of the existing sections and the subdivisions of others; in addition, modifications of the boundaries of surveyors' and superintending engineers' districts were proposed with a view to secure that, generally, they should be co-terminous, and that the common boundary in each case should be that provided by a number of the new areas.

Ultimately, the Postmaster-General approved a re-arrangement based on the Committee's recommendations, whereby each telephone district is wholly contained within one surveyor's district and one superintending engineers' district; and, except in four instances—Blackburn, Bolton, Douglas, and Jersey—coincides with one or more engineering sections. The result of this re-arrangement, which came into force on October 1st last, is indicated by the following schedule :

Digitized by Google

Surveyors' districts.	Superintending engineers' districts.	Telephone districts.	Engineering sections.	Number of local exchanges.
North-Eastern	Northern	Newcastle	Newcastle 39 West Tyne 45	133
		Middlesbrough	Middlesbrough 19 Darlington 30	
	North Eastern	York	York 34	123
		Hull	Hull 17	
		Lincoln	Lincoln 26	
Leeds (also one town, Bradford in North-Western Surveying District)	North Eastern	West Riding (Headquarters, Leeds)	Leeds 28 Bradford 18	
North-Western	North Western	Lancaster	Carlisle 20 Lancaster 23	127
		Preston Blackburn Bolton	Preston 31 Blackburn 30	
		Rochdale	Rochdale 23	
Liverpool Manchester	South Lancashire	Liverpool Douglas	Liverpool 51	89
		Manchester	Manchester 38	
North Midland	North Midland	Sheffield	Sheffield 32	215
		Nottingham	Nottingham 26 Peterboro' 46	
		Leicester	Leicester 67	
		Coventry	Coventry 19 Northampton 25	
North Wales Birmingham	North Wales	Chester	Chester 48 Bangor 33 Shrewsbury 35	216
		Hanley	Hanley 42	
		Birmingham	Birmingham 58	
South Wales	South Wales	Swansea	Swansea 70	265
		Cardiff	Cardiff 70 Newport 42	
		Gloucester	Gloucester 44 Hereford 39	
Eastern Home	Eastern	Norwich	Norwich 46	160
		Colchester	Cambridge 34 Colchester 74	
		—	Ilford 6	
South Eastern Home	South Eastern	Canterbury	Canterbury 58	202
		Tunbridge Wells	Tunbridge Wells 65	
		Brighton	Brighton 63	
		—	Croydon 16	
South Midland Home	South Midland	St. Albans	St. Albans 62	248
		Reading	Reading 46 Oxford 31	
		—	Kingston 6	
South-Western	South Midland	Guildford	Guildford 34	
		Southampton	Southampton 69	
	South Western	Bournemouth Jersey	Bournemouth 52	
Western	South Western	Bristol	Bristol 77	237
		Plymouth	Plymouth 45	
		Exeter	Exeter 63	
Scotland, East Edinburgh	Scotland, East	Aberdeen	Aberdeen 39 Inverness 26	206
		Dundee	Dundee 89	
		Edinburgh	Edinburgh 52	
Scotland, West	Scotland, West	Scotland, North-West	Stirling 34	185
		Scotland, South-West	Paisley 49 Hamilton 60	
Glasgow	—	Glasgow	Glasgow City 42	

Digitized by Google

Surveyors' districts.	Superintending engineers' districts.	Telephone districts.	Engineering sections.	Number of local exchanges.
Ireland, North.	Ireland	Belfast	Belfast	63
Dublin		Dublin	Dublin	26
			Dublin, West	13
		Cork	Cork	26
			Limerick	19
Ireland, South.			Waterford	24
				171
London postal area.	London	London	—	— 52
				2629

For the present Scotland retains three Surveying Districts—Northern, Midland and Southern—outside Edinburgh and Glasgow, and Ireland three Surveying Districts—Northern, Midland and Southern—outside Dublin.

Each town where a district manager is stationed, with the exception of Bolton, Douglas, and Jersey, will also be the head-quarters of an executive (*i.e.* sectional) engineer, and an assistant district manager will be stationed at each of the following towns, namely:

Barnstaple	Hereford	Peterborough
Bedford	Horsham	Portsmouth
Bradford	Huddersfield	Ryde
Cambridge	Inverness	Shrewsbury
Carlisle	Kirkcaldy	Southend-on-Sea
Chatham	Limerick	Sunderland
Chesterfield	Llandudno	Trowbridge
Darlington	Londonderry	Truro
Derby	Newport (Mon.)	Warrington
Dumfries	Northampton	Waterford
Eastbourne	Oldham	Weybridge
Galashiels	Oxford	Wolverhampton
Harrogate		

The district managers and their staffs are borne on the surveyors' establishment and act with the authority of the surveyors, and the object of the re-arrangements is to secure between the engineering and traffic staffs close personal co-operation in the working and development of the telephone service and at the same time to avoid the necessity of centralising the traffic side of the work in the surveyors' offices.

The district manager will be responsible to the surveyor for the efficiency of the entire telephone service, trunk and local, within his area, and the duties of the position may be summarised briefly as follows:

Digitized by Google

Negotiation of agreements.

Collection of rentals and fees for exchange services and private wires.

Correspondence with subscribers regarding service.

Control of all traffic arrangements and in most cases of exchange operating staffs.

Inspection of exchanges.

Preparation of development figures.

It has already been stated that in London and Glasgow the ex-company's engineering staff and work were transferred to the Post Office Engineering Department on January 1st, 1912, and subsequent to that date similar arrangements were made in regard to certain provincial areas where the conditions were exceptionally favourable, as the Post Office already had a staff employed on telephone engineering work, *e.g.* in Brighton and Cardiff. The remainder of the provincial engineering work was transferred from the district managers on October 1st, in connection with the general re-arrangement and this involved radical alterations in the organisation of the sectional engineers' staffs.

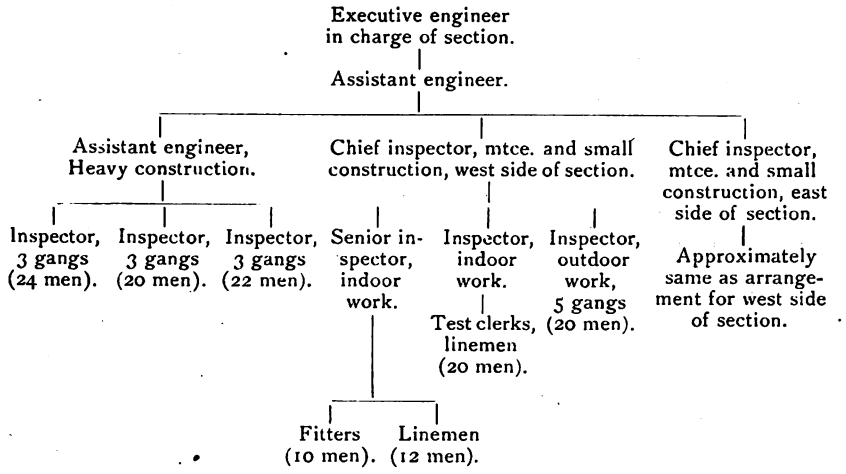
Prior to the date last mentioned it was an invariable rule that the whole of the sectional supervising force, *i.e.* the executive engineer, assistant engineers, and inspectors, were stationed at the headquarters of the section, linemen only being stationed at outlying points. It was also the rule that the division of responsibility between the assistant engineers and inspectors should be functional, not territorial, *e.g.* in a section where two assistant engineers were engaged, the division was usually between construction and maintenance work, but each was responsible for the whole of the work of one class throughout the section, and the same principle applied generally to the inspector's duties.

The work transferred from the district managers is, of course, somewhat different in type from that which constituted the previous "load" in most provincial sections, consisting in the main of a large number of small works, more or less concentrated at various points, as compared with a comparatively small number of large works extending over long distances. The effective supervision of this former class of work renders it necessary that the officers immediately responsible for the control of the workmen shall be stationed as near the centre of the operations as possible, and the acceptance of this principle involved the abandonment of the system of locating all inspectors at the sectional headquarters. Again, the greatly increased volume of work rendered it impossible in many cases to avoid the creation of subdivisions of the section for the purpose of securing proper control of the maintenance and smaller construction works. Further, it was considered advisable, generally, to separate

Digitized by Google

the larger construction works from the more routine operations already mentioned and to place them under the control of an assistant engineer or a chief inspector.

The present arrangements in the average section may therefore be represented diagrammatically as follows:


Executive engineer in charge of section.
Assistant engineer.
Assistant engineer, Heavy construction.
Chief inspector, mtce. and small construction, west side of section.
Chief inspector, mtce. and small construction, east side of section.
Inspector, 3 gangs (24 men).
Inspector, 3 gangs (20 men).
Inspector, 3 gangs (22 men).
Senior inspector, indoor work.
Inspector, indoor work.
Inspector, outdoor work, 5 gangs (20 men).
Test clerks, linemen (20 men).
Approximately same as arrangement for west side of section.
Fitters (10 men).
Linemen (12 men).

In certain of the larger provincial cities a modification of this organisation has been introduced, for example, at Manchester, the indoor work has been separated from the outdoor work and placed under the control of one executive engineer whilst for outdoor work the same area has been divided into two sections each controlled by an executive engineer. The general effect of this organisation of the executive engineering work will be to secure prompt treatment of all day-to-day orders for new circuits and alterations to existing circuits without interfering with the progress of the larger works such as the provision of additional trunk circuits or the substitution of underground for overhead plant: it will also permit of the more ready localisation of abnormal pressure or the reverse.

In conjunction with the general re-arrangement in the provinces, important changes took place in the London area, namely:

(1) The contraction of the area so as to coincide with the London postal district, involving the transfer to provincial engineering districts of the outlying portions of the London telephone area.

(2) The concentration of supervision of engineering work in the London district under one superintending engineer.

(3) The re-arrangement of engineers' sections in the London District.

The effect of the last-named change is that there are now in the

Digitized by Google

London Engineering District fourteen engineering sections, each controlled by an executive engineer, namely:

For internal work: City, Centre, West, South, North East and Central Telegraph Office.

For external work: City, Centre, North, East, West, North-West, South-West, South-East.

The Post Office Telephone Society of London.

The first meeting of the 1912–13 Session of the London Telephone Society, which has now modified its title to The Post Office Telephone Society of London, was held on October 7th, the special feature of the evening being the Presidential address of Mr. A. M. J. Ogilvie on the State Telephone Service, which we report on p. 407.

The society aims at providing a means for the inter-communication of ideas and opinions between all the various organisations which make up the telephone service, and its membership basis is a very wide one, namely, all members of the staff connected directly or indirectly with the Post Office. We reproduce, hereunder, the programme for the 1912–13 Session. While the titles of the papers would appear to indicate in some cases that they deal with subjects of a specialised engineering character, and which should, therefore, be more suitable for our own Engineers' Institution, it will be remembered that it is the aim of the writers to put their ideas into a form which will appeal to an audience drawn from all the various classes. A very excellent feature of the periodical meetings is the demonstrations of various kinds which precede the reading of the papers, and this is a feature which might very well be imitated at our own institution meetings.

The programme for the Session, as at present arranged, is:

1912.	6 p.m. to 7 p.m.	7 p.m. to 9 p.m.
	October 7th.—Demonstration.	Presidential Address.
	November 6th.—Demonstration.	Paper on "Telephone Area Transmission Economics." Harvey A. Smith.
	December 2nd.—Demonstration.	Paper on "Development in Relation to Distribution." F. G. Baldwin.
1913.		
	January 2nd.—Demonstration.	Paper on "Traffic." H. Corner.
	February 3rd.—Demonstration.	Paper on "Trunk Workings." H. G. Trayfoot.
	March 5th.—Demonstration.	Paper on "High-Frequency Measurements." R. M. Chamney.
	April 7th.—Demonstration.	Annual Competition.

Digitized by Google

COUNCIL NOTES.

THE Council desire to bring to the notice of readers the following brief statement of the objects and privileges of membership of the Institution of Post Office Electrical Engineers.

OBJECTS.

The primary object of the Institution, which was founded in 1905, is to assist officers of the Engineering Department in their efforts to keep abreast of the advance of scientific and technical knowledge, (1) by providing opportunities for the open discussion of matters of common interest, and (2) by bringing within the reach of every member increased facilities for private study. To attain these ends, periodical meetings of the staff are held in London and at the headquarters of the various provincial districts; a central lending library, and a local reference library in each district, have been established; technical periodicals are circulated, and selected original communications to the Institution are printed and distributed to the members.

PRIVILEGES.

(*a*) Free conveyance between the members' headquarters and the meeting-place, and subsistence allowance in the event of unavoidable night absence;

(*b*) The use of the lending library as well as of the local reference library;

(*c*) Choice of one technical periodical;

(*d*) Free copy of each printed paper issued by the Institution during membership;

(*e*) Right to vote in all elections of officers, etc.

MEMBERSHIP AND SUBSCRIPTION.

Officers on the engineering and clerical staffs of the Engineer-in-Chief, shown below, are eligible for membership in virtue of their official position, and, as it is the aim of the Institution to assist every officer equally, the usual formalities incidental to admission to such an institution are dispensed with. Membership is open to engineers of all grades, to first, second, and third-class clerks, also to chief inspectors. The admission of senior inspectors and inspectors, as associates, is under consideration at the present time, and it is hoped that Treasury authority for this extension will shortly be granted.

The subscription is 5s. per annum, payable in advance on April 1st each year, and the Council venture to suggest that in few, if any, other institutions or societies of the kind is the relation between contributions and advantages so favourable to the members.

Digitized by Google

Meetings.

For the purpose of holding meetings the Institution comprises 15 centres—(*a*) the Metropolitan centre, which includes the Engineer-in-Chief's office, the Metropolitan Engineering, and the South-Eastern Districts of England; (*b*) 11 Provincial Centres corresponding with the remaining English and the two Scottish Engineering Districts; and (*c*) a Provincial Centre in Ireland. The meetings are open to any officer who is eligible for membership of the Institution, but membership carries with it the privileges of free travelling, under the ordinary official regulations, between the member's head-quarters and the place of meeting.

Lending Library.

At the present time the library comprises more than 850 books, representing 650 different works on civil, mechanical and electrical engineering, magnetism and electricity, mathematics, physics, chemistry, telegraphy, telephony, and various subsidiary scientific and technological subjects. The period of loan is indefinite unless a book is required by another member, when the maximum period is fourteen days; but there is no restriction as to the number of works which a member may borrow at one time. Frequent additions to the library are made by a special committee of the Council, to which all suggestions are referred.

Reference Libraries.

A reference library has been installed in each superintending engineer's office for the use of members stationed in the district. These libraries consist of about 30 standard text-books and works of reference which are in frequent demand.

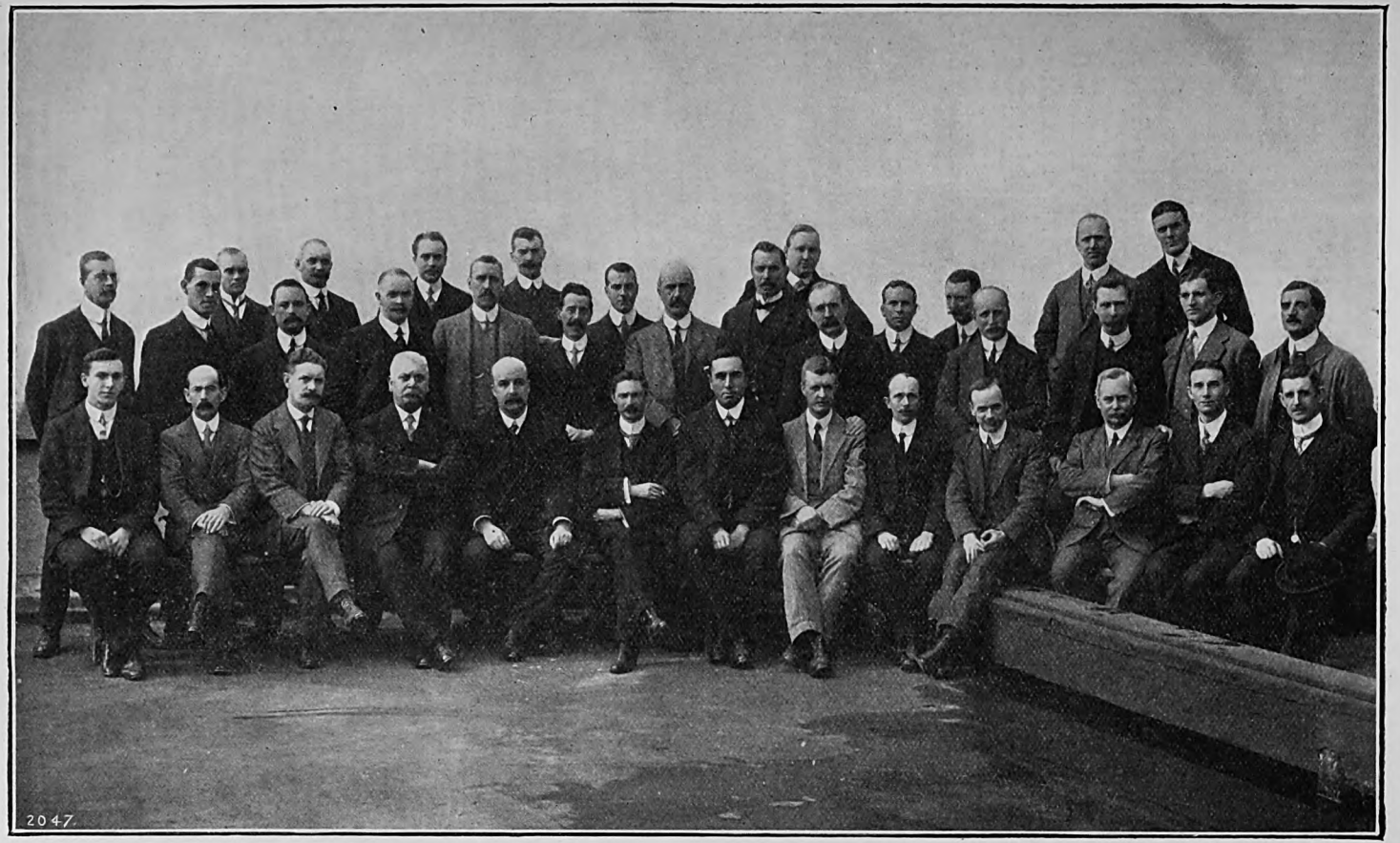
Technical Periodicals

are circulated to each member who expresses a wish to that effect. The list, from which one may be selected, is as follows: English—'Electrician,' 'Electricity,' 'Electrical Engineer,' 'Electrical Engineering,' 'Electrical Review,' 'Engineer,' 'Engineering'; American—'Scientific American and Supplement,' 'Telephony,' 'Electrical World.'

Printed Papers.

Each member is entitled to one free copy of each printed paper which is issued by the Institution during the period of his membership, and is also entitled to purchase, at half the sale price, additional copies of such papers and of printed papers contributed prior to the commencement of his membership.

Digitized by Google



Back Row.—W. W. Smith. G. F. Beer. T. Johnston. F. E. W. Cowie. T. T. Partridge. A. J. H. Sprague. G. F. Bellwood. J. S. Elston. S. A. Seys.
Middle Row.—D. S. Arundel. J. E. Fletcher. A. Rattue. J. Dickson. W. F. Walby. J. Jones. A. W. Teggins. T. E. Devonshire. J. C. Jones. A. H. Mackrill. E. Palk. A. O. Gibbon. D. Spottiswoode. H. F. Picker.
Front Row.—C. Hitzlberger. C. Leigh. G. Richardson. J. W. Barber. W. E. Twells. A. L. de Lattre. H. Brown. F. W. Cheshire. J. I. Smith. W. H. Thornburn. G. Pestell. F. W. Atkinson. C. J. Sirett.

Photo by H. C. Harris.

Digitized by Google

LOCAL CENTRE NOTES.

LONDON CENTRE.

An interesting function took place at the first meeting of the present session of the London Centre, when the Postmaster-General attended to present the Institution medals and awards.

Mr. Samuel was received by Mr. A. J. Stubbs (a Vice-President), Mr. H. R. Kempe (Chairman of the Council), and Mr. A. L. De Lattre (Chairman of the London Centre), and was given a cordial welcome upon arrival by the members and visitors present.

Mr. Stubbs, in asking Mr. Samuel to present the medals and prizes, said:

Gentlemen,—A very honourable duty devolves upon me this evening, although I think it may be a very brief one. Your expression of thanks to the Postmaster-General for his attendance this evening has already been indicated, and I have no doubt that further enthusiastic indication of your appreciation of his kindness will be forthcoming later on. Mainly, his attendance is due to the fact that there are certain medals to be presented to members who read papers of special merit before the Institution during the 1910–11 session, and I think we may depend upon it that the Postmaster-General fully understands and appreciates the work that the Institution is doing, and the energy and ability with which so many members are coming forward to help clarify our ideas in regard to some of the great and increasingly important duties of the Post Office Engineering Department.

The membership of our Institution now reaches 862, and no doubt that number will continue to show a tendency to increase, as it has done in the past. We have not yet got to 100 per cent. of the possible membership.

Perhaps it will be convenient if I refer to the papers in respect of which there are to be recipients of medals.

The senior silver medal is being awarded to Mr. J. Sinnott, for his paper on "Fire Alarm Systems," which has been adopted by the Department as a Technical Instruction.

The junior silver medal to Mr. J. G. Lucas, for his paper on the "Life and Behaviour of Primary Batteries for Telephone Purposes." I well remember the interest that this paper provoked at the Paris Conference.

The senior bronze medal goes to Mr. A. S. Renshaw for his paper on "Methods of Statistics."

The junior bronze medal is awarded to Mr. Percy Dunsheath for

Digitized by Google

his paper on "Fundamental Principles of Modern Internal Combustion Engines."

Major O'Meara, whom we have the honour and pleasure of seeing with us this evening, offered two prizes of three guineas each, and these are awarded to Mr. L. B. Turner, for his paper, "The Low-Frequency Circuit in Spark Telegraphy," and to Mr. P. E. Milford, for his paper, "Office Organisation and Equipment."

You are aware that these papers were restricted in this sense: that one prize was to be awarded to engineers and the other to engineering officers on the clerical establishment.

The Central Lending Library continues to attract a good deal of patronage, and one hears very frequently what a really useful work it is doing. The requisitions for books during last year reached 860. When we remember that this is not simply a lending library for light literature this number seems very satisfactory.

The POST OFFICE ELECTRICAL ENGINEERS' JOURNAL also continues to show great success. It came under my notice last week that the Secretary of the Post Office was asking if there were any similar journals produced by other engineering organisations abroad, and we were able to tell him that two very important foreign administrations had started journals of this kind, and the very get-up of them—except for the very generous supply of illustrations that we enjoy—was markedly on the basis of our own JOURNAL.

I will ask the Postmaster-General if he will do us the honour to present these medals and prizes.

The Postmaster-General, after presenting the medals and prizes, said:

Mr. Chairman and Gentlemen,—I can heartily say how glad I am to be able to get away from other duties for even a short time in order to perform the pleasant ceremony which has just taken place, and I will also, on behalf of you all, I am sure, congratulate the recipients of the medals and other prizes.

The Institution, I know, does much to maintain a high standard of professional ability and skill among the engineering staff of the Post Office. The lending library must be of the greatest possible value, especially to engineers who are stationed in places where technical literature is not easily accessible; and the technical publications which the Institution circulates amongst its members must also be of the greatest use. The reading of these papers necessarily is of high instructive value to the officers who attend to hear them read; but the benefit is not restricted to them, as, I am sure, the writing of the papers is of great value to the authors. It has been well said that the best way to learn about a subject is to write a book on it, and similarly also the necessity of reading a paper

Digitized by Google

before colleagues whose technical capacity may not be unequal to one's own is in itself a very valuable form of education.

I have no doubt that as years go on the Post Office Engineers will find fresh and fresh worlds to conquer. My friend Sir William Crookes recently sent me a copy of a magazine article which he wrote twenty years ago—in 1892—in which he foretold very clearly the triumphs of wireless telegraphy, and indicated the course which this science might take, and the results it would probably achieve. In the course of that article, which I read through only a few days ago, he indicated that there were other matters to which the electrical engineer might with advantage devote his attention in years to come. He apologises for making these suggestions, as they might earn him the name of a dreamer, but one of them was this:

"Another point at which the practical electrician should aim is nothing less than the control of the weather. Cannot the accumulations of electric energy in the atmosphere be thwarted, dispersed, or turned to practical use? In like manner we may hope to abate the terrible fog nuisance. It has been shown that during a genuine London fog the air is decidedly electro-positive, and it would not be difficult to show what the effect of neutralisation would be."

There is a suggestion which I lay before the Institution of Post Office Engineers, for the last few days have shown us with what gratitude the achievement would be received, if any Post Office engineer who, in his spare time, when his light day's work is done, and during his many wearisome hours of leisure, devoted himself to a little original research; and ultimately, perhaps, from the Post Office may arise the discoverer of the method of dealing with the London fog. Neutralise the positive electricity; and the man who achieves that will have erected in his honour statues of gold in every city in the Kingdom.

Turning to more practical matters, the Post Office engineering staff has been passing through periods of re-organisation that have given rise to some little difficulty here and there. The business of the heads of the department is, in the first place, to secure the highest possible efficiency of the service, and also to secure the comfort and contentedness of the staff; but there are cases, individual cases here and there, to put it very delicately, where those two objects cannot be simultaneously achieved, and I hope that the reconsideration which has been given to the question of the classification of the engineering department—very careful reconsideration—will remove some of the unhappiness which I know has prevailed in certain quarters amongst the staff. I am glad to say that, although that reconsideration has taken a considerable time, owing to the many individual cases that had to be most carefully examined and reviewed, a decision has been reached. It will be announced

Digitized by Google

very shortly, and it is of a character which will, I think, bring feelings of satisfaction to a very considerable number of officers.

The staff also has been passing through a difficult period, on account of the amalgamation of the Post Office engineering establishment with that of the late National Telephone Company, a task of the greatest magnitude, and also, of course, of the greatest delicacy. It is like the amalgamation of two armies—not only of the rank and file, but also of the generals—and I might say it had to be conducted while under fire from the enemy all the time. However, it has now, I think, been satisfactorily accomplished, and is almost completed, and I must express my gratitude to those who have in so many instances subordinated personal considerations for the benefit of the service as a whole, and who have worked zealously and hard to secure the greatest possible efficiency of our service. Those troubles now are nearing their end. The telephone service throughout the kingdom has undoubtedly improved during the last few months, and I hope that the improvement will continue, and that the country will have the highly efficient telephone service it has a right to expect. To that end, and to the work of the telephone in general, the Post Office Electrical Engineers' Institution will, I am sure, very largely contribute.

Unfortunately, Mr. Samuel's presence being required at the House of Commons, he had to leave the meeting before Mr. Myles Hook gave his excellent paper.

Mr. Stubbs, in proposing a vote of thanks, which was carried by acclamation, said :

Gentlemen, — As the Postmaster-General is much given to working overtime, I think perhaps it is most desirable that we should make sure that he receives our formal thanks to him at an early stage in our proceedings—not by any means as a hint that we want him to go, but as an expression of regret that we fear he may have to go before our proceedings come to a termination. As Post Office engineers, we very frequently think that we work pretty hard, but we very rarely work more than twenty-four hours a day, and we usually manage somehow to squeeze in a little sleep in the course of our journeys. But I feel that that qualification gives us the means of sympathising with a busy Cabinet Minister of the present time. The Postmaster-General's work is like a woman's—it is *never* done ; and we realise that, and it makes us feel all the more grateful to him for giving us the time he has done this evening. I thank him very heartily in your name for having honoured us with his presence.

The Postmaster-General, in acknowledging the vote of thanks, said :

Gentlemen,—I must thank you for the vote which you have

Digitized by Google

been good enough to express to me. It has been a great pleasure to come. I am sorry that I have not to go soon, but at once. I have already opened an exhibition this afternoon. There are divisions going on in the House of Commons all the time, and my table there is simply stacked with papers. Mr. Stubbs says my work is like a woman's—is *never* done: by which I presume he means that it is never finished. I do endeavour, however, every day to clear my table of papers, and as my table at the House of Commons is very heavily burdened at the present time, I have a long evening's work before me, and I must express my deep regret that I am unable to hear Mr. Myles Hook read the paper which is to form the subject for this evening.

Mr. R. Myles Hook was heartily congratulated by Sir A. F. King upon the reading of his interesting and instructive paper on October 14th. Messrs. H. R. Kempe and G. M. Carr took part in the discussion.

The complete programme for the 1912–13 winter session is as follows:

1912.

October 14th.—"Correct Time." R. Myles Hook.

November 11th.—"Alternate Current Measurement." Chas. E. Hay.

December 9th.—"Directive Wireless Telegraphy." F. Addey, B.Sc.

1913.

January 13th.—"The Electrophone Service." J. H. Pattman.

February 10th.—"Loading Coils." S. A. Pollock.

March 10th.—"Trunk Telephone Communication." A. B. Hart and W. J. Hilyer.

April 21st.—Annual General Meeting.

On November 11th Mr. Chas. E. Hay read a highly scientific paper giving the results of his own research work in the domain of "alternate current measurement."

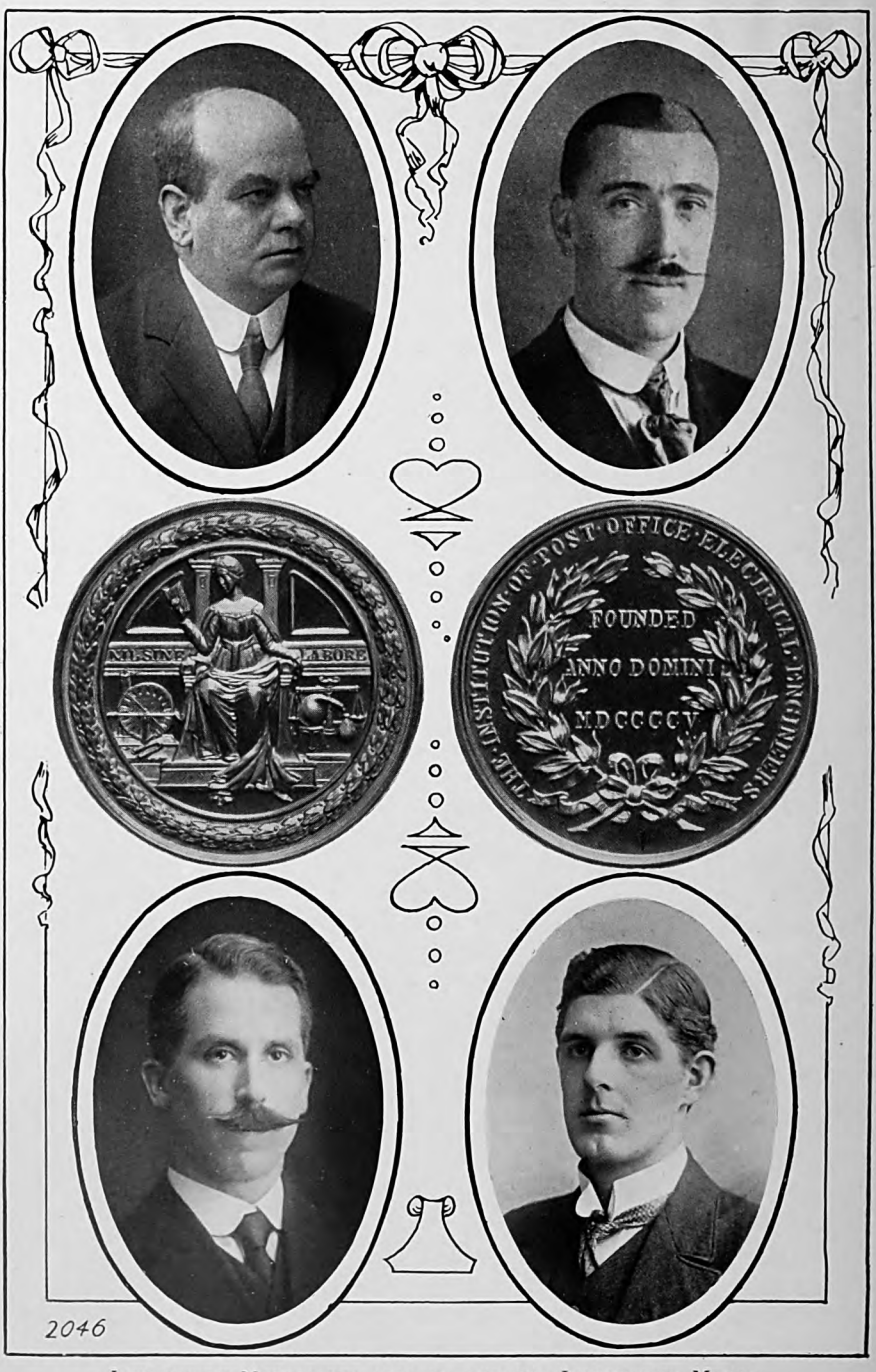
The reading of the paper gave rise to a lengthy discussion, in which Messrs. J. E. Taylor, R. W. Callender, B. S. Cohen, J. G. Hill, S. A. Pollock, A. G. Lee, F. Addey and L. B. Turner took part.

An interesting feature in connection with the Centre meetings is the frequent presence of visitors.

On October 9th a party of thirty members visited the cement works of Messrs. White Bros. at Swanscombe, Kent. The party met with every courtesy at the hands of the members of the staff who were detailed to receive them, and were shown every operation of cement making and also the methods of testing. The arrangements for the manufacture of cement are so elaborate that it

Digitized by Google

Digitized by Google



INSTITUTION MEDALLISTS, 1910–11, AND THE INSTITUTION MEDAL.

1.—MR. J. SINNOTT.
2.—INSTITUTION MEDAL (OBVERSE).
3.—MR. A. S. RENSHAW.
4.—MR. J. G. LUCAS.
5.—INSTITUTION MEDAL (REVERSE).
6.—MR. P. DUNSHEATH.

Digitized by Google

occasioned no surprise when the members were informed that, if necessary, an order given in the morning could be executed the same day, even if there was no stock to fall back upon; in other words, cement could be manufactured ready for use in a day.

The party returned well satisfied with their visit to Swanscombe.

INSTITUTION MEDALLISTS.

WE publish on the opposite page photographs of the gentlemen who have been honoured by the Council of the Institution of Post Office Electrical Engineers for meritorious papers read at Local Centre meetings during the 1910–11 Session. Particulars of the papers are given under the London Centre Notes on page 480 of this issue.

Mr. J. Sinnott, M.I.E.E., is a staff-engineer in charge of the Construction Section, Engineer-in-Chief's office.

Mr. J. G. Lucas is an assistant engineer attached to the Telephone Section, Engineer-in-Chief's office.

Mr. A. S. Renshaw is chief clerk in the office of the Superintending Engineer of the North Wales District, Shrewsbury.

Mr. P. Dunsheath, B.A., B.Sc., A.M.I.C.E., A.M.I.E.E., is an assistant engineer attached to the Electric Light and Power Section, Engineer-in-Chief's office.

NORTH-WESTERN CENTRE.

PROGRAMME, SESSION 1912–13.

1912.

October 8th.—Opening Meeting. "Reminiscences of the Past." H. R. Kempe (Chairman of Council).

November 11th.—"'National' Transfer Arrangements" (Discussion). Opened by the Chairman (T. E. P. Stretche).

November 25th.—Visit to Messrs. Horrocks, Crewdson & Co.'s Cotton Mill.

December 9th.—"Stresses in Telegraph Construction." W. Moon.

1913.

January 13th.—"Telephone Development" (Discussion). Opened by W. J. Finlayson.

* January 27th.—Visit to Messrs. Pilkington's Pneumatic Engineering Works.

February 10th.—"Cash Accounts (Lodging Allowances, etc.)." J. Cooke.

* March 10th.—Visit to Messrs. Dick, Kerr & Co.'s Electric Works.

Arrangements for other meetings are in hand.

* Provisional dates.

Digitized by Google

The opening meeting of the 1912–13 Session was held in the Lecture Hall of the Preston Scientific Society on Tuesday, October 8th, 1912.

The Superintending Engineer (Mr. T. E. P. Stretche) occupied the chair. The members of the Council of the Institution, who were visiting Preston, were also present, together with a good attendance of members attached to the Local Centre.

Mr. Stretche, in his opening remarks, expressed the pleasure it gave the Centre to see the members of the Council, including their Chairman (Mr. Kempe), and extended a hearty welcome to those present. After referring to the programme which had been arranged for the forthcoming Session, the Chairman called upon Mr. Kempe to read his paper entitled "Reminiscences of Telegraphy of the Past."

The lecturer dealt with the history of telegraphy from 1837 until the present day, in a highly interesting manner, and the paper was profusely illustrated by electric arc lantern, under the direction of Mr. J. W. Graham, upwards of fifty excellent slides being exhibited.

Mr. J. W. Sullivan (Assistant Superintending Engineer), in proposing a vote of thanks, expressed the indebtedness of the local centre to Mr. Kempe for his kindness in affording the members the opportunity of hearing such an instructive paper. Mr. C. Whillis (Executive Engineer, Carlisle) seconded, and in the course of his remarks paid a tribute to the practical utility of the lecturer's annual publication ('Kempe's Year Book') in commercial circles; this had come to special notice in conversation with a responsible official connected with a well-known engineering firm. The appreciation of the lecture was demonstrated in no uncertain manner by the unanimous and prolonged applause which followed.

Mr. Kempe suitably replied, and a vote of thanks to Mr. Stretche for presiding terminated the proceedings.

NORTH-EASTERN CENTRE.

An admirable programme has been arranged for the 1912–13 session, which is shown in detail below:

PROGRAMME.

1912.

October.—"Reminiscences of the Telegraph." H. R. Kempe.
November.—"Automatic Telephones."
December.—"Cash Accounting Systems." J. C. Butterfield.

1913.

January.—"Some interesting Wayleave Decisions." G. H. Hoole.
February.—"Some Notes on Official Correspondence." P. A. Corney.
March.—"Heavy Engineering Work in the Post Office." P. F. Attrill.

Digitized by Google

An interesting session is assured both for the engineering side as well as the clerical. Mr. H. R. Kempe favoured us with his interesting lecture, "Reminiscences of the Telegraph," on October 20th. The lecture room at the Leeds University was kindly lent for the occasion, and about sixty gentlemen were present. Mr. T. B. Johnson occupied the chair, and Mr. Sanderson, the postmaster-surveyor of Leeds, proposed the vote of thanks which was seconded by Mr. A. Longden.

The meeting was most enjoyable, and an ideal one for the opening of the session.

Mr. J. C. Butterfield on November 11th read a paper explaining the present departmental method of cash accounting, and the subject, which was dealt with in a thorough manner, proved very helpful to the members present.

SCOTLAND WEST CENTRE.

The meetings have been rather late in getting started for the session, but several very interesting lectures have been promised.

The first meeting will be held on December 9th, when a paper will be read by Mr. J. Cameron on "Some Practical Calculations and Notes on Building Construction."

PROGRAMME.

1912.

December 9th.—"Building Construction." J. Cameron.

1913.

January.—"Small Pneumatic Installations in Post Offices." R. Cunningham.

February.—"The Economical Arrangement of Plant." R. A. Weaver.

March.—"Notes on Underground Construction." J. Hardie.

April.—"Subscribers' Circuits." J. Richardson.

SCOTLAND WEST LOCAL CENTRE COMMITTEE.

Mr. D. Stewart (*Chairman*), Mr. R. A. Weaver (*Vice-Chairman*), Mr. A. Mackintosh, Mr. A. S. Angwin, Mr. H. McCallum, Mr. G. A. Struthers (*Hon. Secretary*).

SOUTH LANCASHIRE CENTRE.

The first meeting of the Session was held on November 25th, and there was a good attendance of members and visitors. The chairman of the centre delivered his inaugural address, which

Digitized by Google

covered a wide field, and was listened to with great interest. A vote of thanks for the address was passed unanimously.

PROGRAMME.

1912.

November 25th.—Chairman's address.

1913.

January 6th.—"Underground Construction." J. Crane.
February 3rd.—"Estimating by Sectional Engineers." J. F. Fletcher.
March 3rd.—"Notes on Engineering Materials." W. B. Smith.
April 7th—(Arrangements not yet completed.)

DUBLIN CENTRE.

The opening meeting of the 1912-13 Session was held at Aldborough House, Dublin, on November 21st, 1912, when thirty-one members were present. Major Turner occupied the chair, and in his opening address congratulated the Dublin Centre on a substantial increase in the membership. He looked forward to a successful session, and announced that, in addition to regular meetings having been arranged up to February next, a visit to Messrs. Guinness and Sons brewery had also been arranged to take place on December 11th. He extended a cordial welcome to members from the ex-National Telephone Company, and hoped they would contribute papers.

Mr. Monaghan was then asked to read the first part of his paper on "Low Pressure Hot Water Heating Systems," which proved most interesting and instructive, and was very highly commended. A good discussion followed, but criticism generally has been reserved for the second part of the paper, which Mr. Monaghan will read on December 10th at a meeting to be held, by kind permission, in the Royal College of Science, Dublin.

PROGRAMME.

1912.

November 21st and December 10th.—"Boilers and Heating." T. J. Monaghan.

1913.

January 16th.—"Lifts." J. McCarthy.
February 20th.—"Electric Lighting." J. W. O'Neill.

SCOTLAND EAST CENTRE.

1912.

December 4th.—"Underground Construction from the Point of View of Maintenance." R. J. Lawson.

Digitized by Google

SOUTH-WESTERN CENTRE.

1912.

November.—President's Address. F. Tremain.

December.—"Bournemouth Exchange Transfer." A. E. Chapman.

1913.

January.—Short Papers. (General Discussion.)

February.—Ditto.

March.—"Land's End Wireless Station." C. J. Roach.

SOUTH WALES CENTRE.

1912.

October 8th.—"Technical Instruction XIII." J. H. M. Wakefield.

November 12th.—"Neath Transfer and C.B. 12 Exchange." H. Cranage.

December 10th.—"Fire Alarm Systems." W. B. Edwards.

1913.

January 14th.—"Worcester Transfer and C.B. No. 10 Exchange." W. H. Lane.

February 11th.—Selected Subject. H. G. Tissington.

March 11th.—"Wireless Telegraphy." W. Pennington.

SOCIAL NOTES.

LONDON ENGINEERING DISTRICT—BOHEMIAN CONCERT.

THE first Bohemian Smoking Concert instituted by the G.P.O. Engineering Department (London Engineering District) took place in the Grand Hall of the Bridge House Hotel, London Bridge, S.E., on Tuesday, December 3rd, Alexander Moir, Esq. (Superintending Engineer, London), being in the chair, and D. H. Kennedy, Esq. (Assistant Superintending Engineer), officiating as Vice-Chairman.

An excellent company of well-known artistes was procured by Mr. Roland Turk, the hard-working musical director, and the large audience present showed very considerable appreciation of the admirable concert which was given. The ladies who contributed to the programme were Miss Christine Brougham and Miss Alys Digby (songs at the piano), Miss Constance Hazeldene (elocutionist), Miss Dora Lucas (soprano), and Miss Winnie Melville (Vaudeville artiste), all of whom acquitted themselves with much credit. The other items of the programme included Mr. Harry Hall, with his excellent rendering of "The Country Curate"; Mr. Will Edwards, jun., in "The Wedding"; Mr. Frank Hudson (C.T.O.), and Mr. John E. Nester (the Modern Jester), while the serious part

Digitized by Google

of the programme, so far as the male element was concerned, was safe in the hands of Messrs. Bernard F. Wates, Norton Carpenter (tenors), and Arthur Ackerman and J. W. Kimber (baritones). The latter gentleman's song, "The Floral Dance," was excellently rendered and much appreciated. Mr. Charles Aigrean (the Original Grey Coon) also assisted in selections from his *repertoire*. Mr. E. L. Papworth acted as accompanist throughout the evening, and opened the proceedings with Sinding's "Frühlingsrauschen," a most excellently played pianoforte solo.

In accordance with the custom of recent years, the speeches, which were very well received, were brief, votes of thanks being passed with acclamation to the Chairman, the artistes, the Committee, and the ladies, and being responded to in few but well-chosen words. The speakers were Mr. Moir (Chairman), Mr. Kennedy (Vice-Chairman), Mr. Greenham and Mr. Roland Turk; Mr. Ernest Bland passed a vote of thanks to the ladies.

Mr. Turk and his able assistant musical director, Mr. J. G. Phillips, whose efforts in the promotion of the concert were well seconded by the Misses H. Hammond, D. I. Mills, D. Wallace and Mr. G. H. Cole (Stewards), and the members of the Committee, Messrs. J. H. Bach, E. J. Bland (Hon. Treasurer), J. C. Cree, E. P. Gayler, J. W. Lyon, E. L. Papworth (accompanist), W. J. Peacock, and S. G. Pettitt, all of whom worked very hard, are to be congratulated upon the success of their initial undertaking, and it is hoped that the function will be followed by others of a similarly enjoyable nature. It is understood that the financial result is eminently satisfactory, and as the proceeds of the concert are to be devoted to the Rowland Hill Benevolent Fund, the concert executive will have the pleasure of knowing that their work has served the two-fold purpose of charity and enjoyment.

CORRESPONDENCE.

MURRAY AUTOMATIC *v.* WHEATSTONE.

To the Editors of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

DEAR SIRS,—I shall be glad if you will allow me to correct one or two slight errors into which Mr. Lockhart has fallen in your issue of October, 1912, in his very interesting article on Wheatstone working in Canada. On page 293 Mr. Lockhart says the length of the line from St. Petersburg to Omsk in Siberia is 2400 miles. If Mr. Lockhart will refer to page 500 in my paper on "Practical Aspects

Digitized by Google

of Printing Telegraphy," 'I.E.E. Journal,' vol. xlvii, 1911, also to the appendix on pp. 515 and 516, he will see that the length of the line is 2224 miles.

Mr. Lockhart takes five letters as the usual basis per word; but he appears to have forgotten the space at the end of the word. The usual basis accepted now almost universally is five letters, and a space equal to a letter. It is therefore customary to divide the speed in letters per minute by six to get the speed in words per minute. Morse letters average four reversals, and the British Post Office reckons twenty-four reversals per word. This gives six letters per word—that is to say, five letters and a space. Taking Mr. Lockhart's five-letter basis, however, he says the output of the Murray automatic was 72 to 78 words per minute. Referring to page 500 of my I.E.E. paper, it will be seen that the speeds of the Murray automatic are given as 336 to 360 letters per minute. Dividing by five gives 67 to 72 words per minute. I do not understand how Mr. Lockhart arrives at 72 to 78 words per minute.

Mr. Lockhart does not appear to have seen the appendix to my I.E.E. paper giving the Russian official figures and information about the working of the Murray automatic system on the line St. Petersburg–Omsk. The letter from the Russian Director-General of Posts and Telegrams, quoted in the appendix to my paper, after giving particulars of the length of the line, says:

"The line is worked duplex in an entirely satisfactory manner, and it is not necessary to revert to simplex except in the case of very bad atmospheric conditions.

"The regular operation of the Murray automatic apparatus on the St. Petersburg–Omsk line was inaugurated on April 19th, 1908.

"The speed of transmission in each direction with the Murray automatic system, working duplex, is from 56 to 60 words a minute.

"The speed of transmission by the Wheatstone system on the same line did not attain more than 30 words a minute (six feet of tape), rarely 35 words (seven feet of tape), and under the very best conditions, and then only during very short periods of time, 40 words a minute (eight feet of tape)."

It is a pity Mr. Lockhart did not verify his facts before expressing opinions about the Murray automatic system. He says: "These, presumably, are duplex speeds, and I cannot help thinking that the Wheatstone speed is the everyday working speed as against the Murray with highly skilled attention." The official letter of the Russian Government is sufficient answer to this supposition. The Wheatstone was in use between St. Petersburg and Omsk for years before it was replaced by the Murray Automatic. The Wheatstone has been widely used in Russia for many years. The Russians are skilled Wheatstone men, and they employed "systematic Wheat-

Digitized by Google

stone working" with typewriters long before the British Post Office. The results with the Murray automatic were taken under practical working conditions on the Murray circuit in use for three years. The official letter expressly states that the figures given are "practical" data ("*les données pratiques*"), and it adds that these practical results are so much below the theoretical speed, on account of weather, auto-induction of the line, and the reciprocal induction of neighbouring wires running parallel with this line over long distances. The same engineers and mechanics who attend to the Wheatstone in Russia also attend to the Murray automatic.

Why does Mr. Lockhart insinuate that the Murray automatic results are not "genuine"? He says, "In a genuine trial with proper team working, I would still expect Wheatstone, with its single electro-magnet, to come out on top." I fear Mr. Lockhart's expectations are doomed to genuine disappointment. In the genuine trial, or at least I suppose Mr. Lockhart will accept it as a genuine trial, carried out by the British Post Office during a fortnight between London and Dublin in 1908, the Murray automatic output per operator per hour was 31 per cent. higher than the Wheatstone, and the total number of messages handled by the Murray automatic was slightly higher than by the Wheatstone. This was on a comparatively short line, and for years I have pointed out that multiplex systems are superior to automatic systems for lines of moderate length. Apart from news work it is on long lines only (or long underground cables) that there is a field for automatic systems, and on long lines the best automatic is the one using the shortest alphabet, because it can pass the most traffic over the line. On comparatively short lines, of course, the Wheatstone record can be greatly improved by the use of the Gell perforator and the Creed receiving perforator and other devices; but the Wheatstone then is no longer that idol of Mr. Lockhart's heart, "the Wheatstone with its single electro-magnet." The Wheatstone was beaten by the Murray automatic in England on operator averages on a line of moderate length, and in Russia on traffic-carrying capacity on a long line. Under these circumstances it seems to me that the "single electro-magnet" is an idol with feet of clay.

Mr. Lockhart really ought to read up the subject, and make sure of his facts, before expressing opinions about the Murray automatic. I would genuinely invite his attention to the advantages of the Baudot alphabet compared with the Morse. (See "Setting Type by Telegraph," 'Institution of Electrical Engineers' Journal,' 1905, vol. xxxiv, page 555.)

Yours faithfully,

DONALD MURRAY.

Digitized by Google

ELECTROSTATIC CHARGING OF WIRES.

To the Editor of THE POST OFFICE ELECTRICAL ENGINEERS' JOURNAL.

DEAR SIR,—In your issue for April, 1910, there was an article by Mr. R. W. Weightman on the "Electrostatic Charging of Telegraph Wires by Locomotives."

The reading of that article recalled to my mind a severe shock which I received from a suspended aërial line, thirty miles long, in 1902. I could only ascribe this to electrification of the wire by the friction of dry wind on the conductor, but, until the afternoon of August 29th last, I had not observed a recurrence of the phenomenon.

On the latter occasion the afternoon was warm with a strong, dry wind blowing. Upon touching a spare wire running between Beaufort West and Deaar, a distance of 160 miles, I received a severe shock. There are three such wires—each of 150 lb. copper supported on Cordeaux insulators—recently erected, but not yet in use, and all were found to be highly charged. I had no opportunity to make exhaustive tests, but the following facts were observed: (*a*) immediately after touching the wires for a second, they could be freely handled, but if left insulated for a few seconds a perceptible shock was felt; (*b*) if left insulated for a few minutes and then earthed through a galvanometer a spark was observed before the contact was made and the galvo-needle indicated a transient current; (*c*) in both cases the charging of the wire continued steadily for at least an hour.

That the lines in the dry karroo are capable of retaining a charge at a high potential is fairly certain. It is a daily occurrence in dry weather to find the total insulation resistance of a line 600 miles long well over 0·1 megohm, and I have frequently stored a charge at 100 volts (especially a positive charge) in a suspended line for some seconds.

In 1902 I obtained a much brighter spark than recently, and I believe in that case there was no lightning discharger on the line.

R. WATSON.

BEAUFORT WEST;
10*th September*, 1912.

Digitized by Google

LIBRARY NOTES.

THE following books have been added to the Central Library, and are available for issue to members:

No.

458. 'Electricity and Magnetism.' Jean.
459. 'Applied Methods of Scientific Management.' Parkhurst.
460. 'Theory of Structures.' Morley.
461. 'Practical Geometry and Graphics.' Low.
462. 'Gas Engine.' Goldingham.
463. 'Practical Steam and Hot Water Heating.' King.
464. 'Wireless Telegraphy.' Ashley and Hayward.
465. 'Oil Motors.' Lieckfield.
466. 'Elementary Heat Engines.' Jamieson.
467. 'Practical Mathematics.' Bates and Charlesworth.

NEW EDITIONS.

57. 'Telephony.' Poole.
500. 'Infinitesimal Calculus." Carslaw.

ENGINEERING DEPARTMENT CHESS CLUB.

THE Engineering Department Chess Club commenced its ninth session on Tuesday, October 8th, at Ye Mecca, Cheapside. The club maintains its membership, and the attendance is good. It is pleasing to note that many of the transferred N.T. Co. staff have this season become members.

In view of a generally expressed wish, a draughts section has been formed, in the hope that it would form a recruiting ground for chess players.

So far the club has no victories to record, but there is no reason to doubt that it will be more fortunate in 1913.

G.P.O. RIFLE CLUB.

Matches in "Metropolitan League," 1912–13. Shot, 5; won, 5; points, 10.

October 29th (home).—G.P.O. *v.* S.B.D.—G.P.O., 681; S.B.D., 678.

October 30th (away).—G.P.O. *v.* Great Central Railway.—G.P.O, 668; G.C.R., 665.

Digitized by Google

November 12th (home).—G.P.O. *v.* 'Lloyds' Register.'—G.P.O., 684; 'Lloyds' Register,' 671.

November 20th (away).—G.P.O. *v.* War Office.—G.P.O., 673; War Office, 670.

November 27th (home).—G.P.O. *v.* Admiralty.—G.P.O., 682; Admiralty, 681.

Matthew Nathan Cup Competition.

The competition to be open to teams of eight, composed of employees of the Post Office.

The committee has arranged that the larger London and provincial offices shall enter two or more teams, and that those teams shall not be selected from the whole office according to merit (*i. e.* first team, second team, etc.), but shall be representative of different sections of the staff.

It has also been arranged that some of the smaller offices may combine with other neighbouring places to increase the strength of their teams.

Formal entry forms and full particulars may be obtained from Mr. A. J. Bateman, Hon. Secretary to the Committee, G.P.O. North.

FIGHT FOR EIGHT MILLIONS.

Telephone Case Reaches Sixty-third Day.

Sir J. Simon's 410,000-word Speech.

In the sombre Court VIII. of the King's Bench Division the protracted proceedings over the transfer of the telephone system to the Post Office are drawing to a close.

Yesterday was the sixty-third day of the hearing, and if the case has made no new legal reputations it has at least established a forensic record in the nine and a half days of continuous speaking with which the Solicitor-General concluded the argument for the Postmaster-General. Sir John Simon's was an extraordinary performance when the circumstances are reviewed. The highly technical issues arising from the controversy demand unusual mental clarity and concentration, but Sir John's familiarity with every aspect enabled him to dispense with all save the briefest of notes, and he was free from exhaustion when his task was terminated.

Then, too, his evenings were occupied with political work. He was making speeches in the country and in the House of Commons.

Digitized by Google

The Solicitor-General possesses a rare type of mind—a mind in which the different interests and activities are as neatly pigeon-holed as the documents in a lawyer's office. His brain must be "departmentalised" as are the brains of few men.

The evidence in the telephone case fills three quarto volumes comprising 2927 printed pages, and there have been 20,000 questions in the course of leading and cross-examination. The fourth volume was brought into court yesterday morning, and a smile flickered over the Solicitor-General's usually stern face as it was handed to him. It was, with the exception of interpolations and interruptions from the Court and opposing counsel, exclusively his speech, which contained, according to a shorthand writer's computation, 410,000 words, and filled 631 pages.

From the public point of view, probably, there has never been a duller case in the Courts than this in which eight millions sterling are at stake. A man slept peacefully in the gallery yesterday; the wonder is that more in the court do not follow his example. Sir Alfred Cripps, K.C., for the National Telephone Company, is in the midst of his argument in reply to the Solicitor-General, and for hour after hour, leaning upon a pile of volumes, spectacles on the extreme tip of his nose, he battles valiantly for his interpretation of the terms "obsolete" and "inadequate"—vital questions in the proceedings—and, having begun to speak on Friday, expects to go on for another four days. There is considerable searching involved in the books and documents which, with the "authorities" bound in calf from which counsel quotes in support of his argument, rise in a tide to the height of the seats in counsels' pews.

The Matter in Dispute.

Sympathy goes out to Sir Alfred as he observes that it is a case to which minute attention must be paid if it is to be grasped at all.

Mr. Justice Lawrence, with whom are two assessors, says a little wearily: "There are a good many riddles we shall have to solve."

And the layman is appalled by these confessions from responsible quarters of the difficulties with which the experts are wrestling. There is not in the court a single telephone instrument, or any sign of the mechanism round which this fight of the legal wits is being waged, and it is only by listening intently that one may gather that the telephone is in dispute.

The ground of contention, briefly stated, is:

The National Telephone Company value their plant at	£15,871,605
The Postmaster-General argues that it is worth .	7,334,794
Difference upon which the Court has to arbitrate .	8,536,811

Digitized by Google

Each day that the proceedings continue the cost of this litigation mounts up steadily. Mr. Buckmaster, K.C., and two juniors are with Sir John Simon, and the fees of the Treasury counsel will be allotted at the conclusion of the case. On the other side, Sir Alfred Cripps is said to have received a fee of £1500 with the brief, and to be in receipt of £150 per day. He has with him three K.Cs. and two juniors, whose fees range in a descending scale of two thirds that of the counsel engaged immediately above them. Then there are the expenses of solicitors, expert witnesses, and shorthand writers, and the cost of printing to be added—a pretty penny altogether.

Nor will the determination of the present proceedings be the end of the dispute over the telephone transfer. As soon as this point concerning plant has been decided, others—as, for instance, the value of buildings—will have to be examined, and, in the event of no agreement being mutually arrived at between the parties, will be the subject of future litigation, and a pleasant prospect of "pickings" is opened to the legal fraternity.—*Daily Chronicle,* November 26th, 1912.

£20,000,000 CLAIM.

Agreement Reached on all Outstanding Matters.

Attorney-General's Statement.

Important announcements were made to-day at the £20,000,000 telephone arbitration between the National Telephone Company and the Postmaster-General, before the Railway and Canal Commission, as to the agreement of figures between the parties. The Attorney-General (Sir Rufus Isaacs) said that all the outstanding matters that the Court had not yet dealt with had been discussed, and an agreement arrived at. One of these settled items alone involved eighty compensation claims. In regard to plant constructed after the taking of the inventory, the claim was £658,599, and the sum agreed was £439,390. An item of £7592 had been all along agreed for certain plant and assets, and a claim of £6539 for structural alterations and additions to premises had been settled at £6460. There was another item, £181,108, for plant, property, etc., included in a special inventory. £1,250,000 for land and buildings, £243,247 for wayleaves, £211,372 for the licensed telephone business at Portsmouth, Brighton and Hull, and £212,350 for private wire business the Post Office had taken over under agreement. The total claim under these latter heads amounted to £2,098,177, and the sum agreed in settlement was £1,225,000.

Digitized by Google

The claim for stores and tools not included in other claims was £434,749, and the agreed figure was £290,000. For furniture, fixtures, etc., £87,540 was asked, and settled at £87,026.

The total claims he had enumerated amounted, said Sir Rufus, to £3,292,996, and the amount that had been agreed was £2,055,468. These agreements were the result of a reasonable spirit being shown on both sides.

Mr. Justice Lawrence said the Court was relieved to hear that these claims had been disposed of in a business-like way. The disposal of eighty compensation cases and the other matters had relieved the Court of sitting for an almost indefinite period.

The Hon. A. E. Gathorne Hardy later congratulated the Attorney-General upon the interesting event that he had celebrated on the previous day—his silver wedding.

Sir Rufus Isaacs replied that if the case had gone on without any settlements between the parties the Court might have had the opportunity of congratulating him on his golden wedding. (Laughter.)—*The Westminster Gazette*, December 9th, 1912.

HARRY ROBERT KEMPE.

WITH the passing of the Old Year there passed from the active service of the Post Office one of the most notable personalities that the Engineering Department has ever produced. To say this of Harry Kempe seems utterly inadequate, even for an opening sentence, because it does not necessarily express that quality that is perhaps above all his outstanding characteristic—the quality of loveableness.

Born March 1st, 1852, Mr. Kempe is the fourth and youngest son of the late Rev. John Edward Kempe, Prebendary of St. Paul's Cathedral, and for many years Vicar of St. James's, Piccadilly. When Prebendary Kempe died in 1907 he was ninety-seven years old, and was still of such vigour of mind that a comparatively short time previously he had contributed some very interesting letters to 'The Times.' "Our" Mr. Kempe is so like his father in physical and mental equipment that we may well hope that he will live to break the record in the matter of drawing of pension.

However, our duty just now is to look back, not forward, for over forty years to the days when, following an education at King's College, London, Mr. Kempe started his scientific career, first under the late Sir Samuel Canning, and afterwards with the late Sir Charles Wheatstone and the late Robert Sabine. These were the giants of those days, the men of brain, and initiative, the men of genius who did great things in the day of small things. And Harry Kempe caught their spirit. One feels sure that if one had spoken to

Digitized by Google

Wheatstone about Kempe he would have responded eulogistically. It was in those very early years that Mr. Kempe discovered his seafaring qualities, with the result that ever since he has dreaded a "voyage" from Kew to Hampton Court! An exceedingly satisfactory result of this dislike of the ocean is that instead of getting a globe-trotter's "knowledge" of Europe by "Polytechnic" instalments he really knows, as a man knows a friend, some of the most charming of the beauties of English scenery.

I do not know whether it was the experience of his voyage to North Africa that led to his entry into the Postal Telegraph Service; but in 1871 he took up duty at Southampton under Mr. (now Sir) W. H. Preece.

Those were really critical, momentous times. There were authorities who acted as if, and even said that, the technical knowledge and training that they had had—in days when of making of books there was scarcely a beginning—would meet all the needs of the new Postal Telegraph Service; but Preece knew better. With a foresight born of genius he set himself to train brains for the future work; and he selected carefully the right stuff to work upon. Mr. (now Sir) John Gavey was one of his men; Mr. Kempe was another —good samples of a good batch! In due course Preece came to London, and Kempe came too (1878). He was until then a second-class inspector (progenitor of the assistant engineer), but at an even later date the average inspector was of such order that it was seriously suggested that inspectors should wear uniform caps, as water and gas inspectors did! Preece's "inspectors" were not of that ilk!

What a curious sidelight on the vagaries of organisation it is to find that between 1878 and 1882 the erstwhile engineer ("inspector"), on being given higher engineering duties, was classified as a clerk! I fancy that even in those days the TS. test clerks were designated by Mr. Fischer as his "technical officers." It is amusing, therefore, to observe the marked originality of the Department when in 1882 it created its new engineering classes under the designation of technical officers! Mr. Kempe was placed on the second class.

Perhaps we are going too fast! In those earlier days Mr. David Lumsden and Mr. A. Marson were Mr. Preece's chief assistants; Mr. James Hookey was in the same way Mr. Graves' principal assistant. Then Lumsden took charge of the Submarine Department, and J. W. Willmot succeeded. These others were able men, who had grown up with the system; they were well qualified and, in many respects, brilliant pioneers; but it is difficult to conceive what our position would be now if Preece had had no henchmen then who were qualified like Mr. Kempe to uplift the banner of scientific knowledge. History gives no support to the oft-

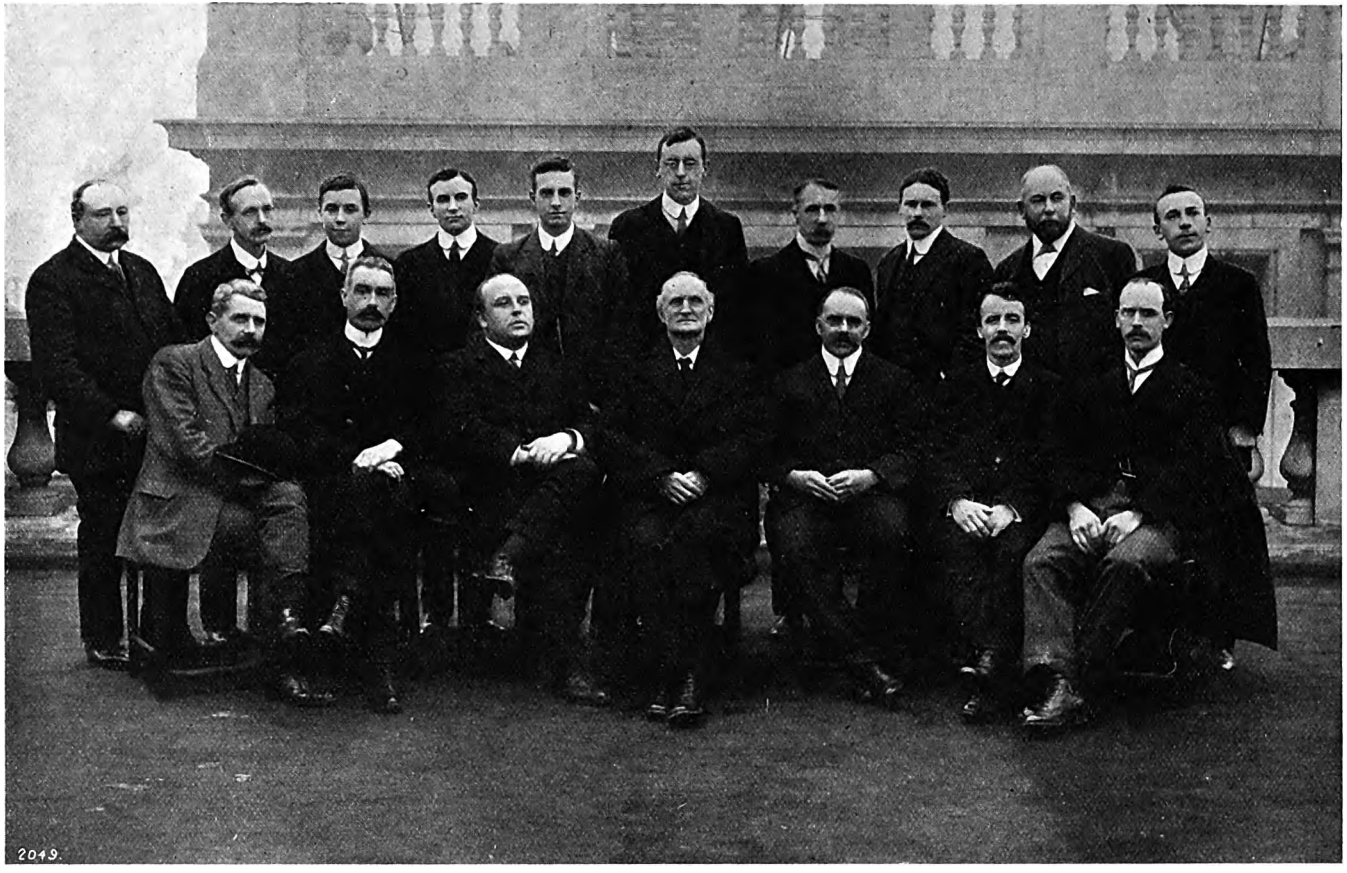
Digitized by Google

repeated claim that the proud position of the Post Office Telegraph System was secured by men without scientific knowledge. It was not, and never could have been, by unscientific, practical men that such position was attained; it was secured by the few men who knew all there was to know in their days, and who strove strenuously to impart that knowledge, but who, above all, had the genius to apply it to the development of the system. It would be interesting to expand this idea, but it must suffice to say that Mr. Kempe was one of these pioneers.

If the editors permit, however, I will make one or two excursions into anecdotage. On one occasion a superintending engineer (the late G. H. Comport) found a water company in great straits because its reservoir overflowed from time to time and flooded the town! The pumping-station was some miles from the reservoir, and the failure of the messenger to arrive at the pumping-station and warn the engineer that the reservoir was full, led to the disaster. Mr. Comport at once said, "Why not register the water level electrically?" Here was the genius of originality. No such thing had ever been thought of before, but Mr. Comport calmly took the order and sent to head-quarters for the design! and it came, in the water level transmitter and indicator, mostly due to Kempe's ingenuity. The transmitter included, what I believe was, an entirely new mechanical device. Often have I admired the marvellously ingenious mechanical devices that have been developed for electrical instruments, and, if ever they were collected simply as mechanical examples, quite a number of them would be found to be due to the originality of Mr. Kempe. We do not readily recognise what this means. For instance, the successive stages by which Wheatstone's transmitter became capable of transmitting 250 words a minute marked an amount of careful design that is worthy of being called invention. Then Mr. Preece casually gave instructions that the speed was to be increased to 400 words, and it was merely a matter of design and not of invention to get that and an even higher speed.

Having referred to mechanical devices, it is not out of place to say here that Mr. Kempe's originality in this direction has been positively boundless. He has revelled in production of new "wrinkles." The "wiper," by which a pendulum records its own stoppage, he introduced when he designed the sounder silencer. The quarter-minute telephone clock includes a slotted cam which is a particularly neat electro-mechanical device. He has produced several testing keys, which, besides being closely associated with another of his special interests, show good analytical power of cause and effect so essential to correct design. These and hosts of others. I remember in one of his researches he fitted up a series of relays and con-

Digitized by Google



Back Row.—W. H. Hayman. W. E. Cooke. M. Eynott. W. L. Merrick. A. B. Morice. C. Robinson. W. H. Godfrey. R. M. Chamney. J. W. Banks. S. Turner.
Front Row.—C. E. Hay. A. Fraser. R. M. Hook. H. R. KEMPE. J. G. Hill. W. A. Hatfield. C. W. Burge.

Photo by H. C. Harris.

Digitized by Google

densers with a key and sounder at opposite ends of the room. You could depress the key and walk across the room to read the signal on the sounder! Of course he wanted to extend the experiment so that if the key was depressed you might have to wait a week for the resulting sound ! !

When first I entered the Post Office he took great interest in the "new boy" who did not know a battery from a galvanometer! And his method of instruction was characteristic. As soon as I knew the difference between resistance and conductivity he gave me the diagram of the Wheatstone Bridge and left me to arrive at the theory! (I proudly gave him the explanation the next morning.)

The Post Office pneumatic tube system has furnished a fruitful field for Mr. Kempe's activities. One notable development should be recorded—the conception of feeding carriers into long tubes on an elapsed time basis. As it was Mr. Kempe's conception, naturally Mr. Kempe produced the apparatus needed to carry it out—which gave scope for further ingenuity.

In 1890 it was decided that telephonic communication with Paris should be provided, and the design of a submarine telephone cable was delegated to Mr. Kempe. The cable so well justified the design that it served as a standard telephone cable until "loading" became practicable. This development too—the provision of loaded telephone cables—has taken effect under Mr. Kempe's ægis as Electrician to the Post Office.

Of course everyone knows his work in the domain of "Electrical Testing," or, at least, all know his book, which has appeared in many languages. There is a great distinction between an "author" and an "authority"—Mr. Kempe is both. He revelled in the mathematics of electricity when most electrical people were grappling with Ohm's Law as the only mathematical formula which they needed.

As an author, too, he has increased his reputation by his 'Electrical Engineer's Pocket Book,' and his 'Engineer's Year Book'; the latter, which justifies its annual edition beyond the usual standard in such connection, is a monument of painstaking industry. Mr. Kempe's name figures also among the contributors to the new 'Encyclopædia Britannica' in respect of articles on telegraphs and telephones and pneumatic tubes.

He has been associated with the 'Electrical Review' from its inception in 1872, and wrote technical articles for the first volume. From that time onward his general editorial experience has been constant and extensive. This experience has been placed ungrudgingly at the service of our own JOURNAL, which he has served as Chairman of the Board of Editors, for over five years.

As Member of Council, Treasurer, and Chairman of Council of

Digitized by Google

the Institution of Post Office Electrical Engineers he has rendered invaluable help to this Institution, which is coming to take a recognised place among the scientific societies.

It would be strange if with such a record Mr. Kempe had been able to keep out of learned societies. In spite of his general tendency to self-effacement he is a Member of the Institutions of Civil, of Electrical, and of Mechanical Engineers, and is also one of the Board of Visitors of the Royal Institution.

One other official position that he holds must be mentioned. Since the formation of the "Awards Committee" in 1906 he has held the responsible and independent position of Chairman of both the Technical and the General section of the Committee. The duty of this dual Committee is to inquire into and adjudicate upon any suggestion that may be made by employees of the minor grades of the Post Office for improvements in plant, apparatus, fittings or stationery. Some 3900 suggestions have been dealt with and over 700 awards have been made under his Chairmanship.

It seems surpassingly strange after the foregoing brief and inadequate note to turn to the official record of these forty-one years of fruitful service and to find: Engineering Dept., S. Div., 1 April, 1873; Engineering Dept., London, 2 Mar., 1878; Principal Technical Officer, 15 Mar., 1900; Electrician, 1 Aug., 1907.

One cannot but wish it could be ensured that men who devote their whole strenuous lives to the service of the public, but not in the public eye, might be more regularly rewarded in a public manner. An officer in the Naval or Military branches of His Majesty's Service does not need to be an admiral or a general before receiving public recognition of his service; but in His Majesty's Civil Service how many, or rather how few, other than actual heads of departments are so honoured.

One could not close this article with such a thought. Kempe *is* honoured by having secured the respect and affection of every officer with whom he has ever been brought into contact. Endowed with all the instincts of a true gentleman, no one has ever had to cultivate a "thick skin" as shield against his control. The missing of his kindly, capable presence at Headquarters will be to a great many one of the notable losses of their official life; and to him we hope it will be an honour, and a glowing testimony to the value of his service and the sincerity of the esteem in which he is universally held in the Engineering Department, and in wider official circles.

This is, perhaps, not the place in which to refer at any length to Mr. Kempe's domestic and social relations. We have reason to know that they have been of the best and happiest. He has lived in the seclusion of his quiet home at Brockham Green for many

Digitized by Google

years; has been churchwarden for practically the whole time, in which office he has spared neither pains nor money to help on the cause of the church. He has been chairman of the parish council from the time of the passing the Act, and if one could look into his inmost thoughts it would probably be found that he is firmly convinced that he rules there with a rod of iron! If golf and photography are types of hobbies, he has none; but his interests are so numerous and wide that at the end of three months from now we expect to hear that he has too much to do.

Dear Kempe, no one has really known what an altogether estimable man he is who has not talked to him as friend to friend. He is himself at his best when there are few to see, and he is such a sympathetic listener that a talk with him is always calculated to bring out the best in another.

Long may he live, and may he always think kindly of the hosts of friends that he has in the Post Office.

A. J. S.

RETIREMENT OF MR. WILLIAM RICHARD CULLEY, I.S.O.

On September 13th, Mr. Culley, having reached the age of sixty, retired from his post of Senior Submarine Superintendent after a unique period of forty-three years in the public service all spent on cable work, and he may therefore be said to be the *doyen* of the cable-laying and repairing fraternity.

Born in 1852 he was the only son of the late Richard Spelman Culley, the first Engineer-in-Chief to the Postmaster-General, and one of the pioneers in electric telegraphy. He was educated at King's College School and at the University of Lausanne, and entered the service of the Electric and International Telegraph Company (of which his father was Chief Engineer at that time) in September, 1869, just prior to its acquisition by the State; was appointed Assistant Submarine Superintendent in 1874, superintendent at Dover in 1890 (on the acquisition of the Submarine Telegraph Company), and in 1898 returned to Woolwich as Superintendent. He has thus served under six Engineers-in-Chief, some of whom—Mr. Graves, Sir W. Preece, Mr. Hookey, and Sir John Gavey—had known him from childhood and whose personal friendship he enjoyed. On the retirement of Sir W. H. Preece he was offered the post of Assistant Engineer-in-Chief, but declined the appointment, preferring to remain at sea at the work he so thoroughly enjoyed and understood.

Early in 1870 he went to sea in the first "Monarch,"—

Digitized by Google

an old wooden paddle steamer—under David Lumsden, to repair the Wexford cable. When in a gale near the Land's End an

WILLIAM RICHARD CULLEY.

accident happened to her machinery which completely disabled her, but she managed to make her way to Penzance under sail. She left there in tow of a tug and repaired the cable in deep water

Digitized by Google

with the tug lashed alongside her, eventually reaching Birkenhead, where she remained for some years as a subsidiary store to the submarine depôt then located at Lowestoft. She was afterwards sold for a coal hulk, and ended her days by being blown up by an experimental mine off the Isle of Wight. This old "Monarch" was the first ship permanently fitted as a cable ship for repairing work, and had one cable drum driven by a belt from an old agricultural boiler. She had no cable tanks, cones or crinolines to facilitate paying out. Each turn of cable in the hold was lashed to the next, and the cable hands lay on their stomachs with knives in their mouths ready to cut the lashings if they did not break at the proper moment in paying out.

After the disablement of the old "Monarch" plans were prepared for a new vessel, but owing to want of Treasury sanction no new vessel came into being until 1883, when H.M. Telegraph Ship "Monarch" was launched, and in the intervening years Mr. Culley served in all sorts of vessels, some regular cable ships, others fitted with a portable cable gear provided by the Department, and some with none. Among these ships may be mentioned the "Robert Lowe" (afterwards lost with all hands off Newfoundland), the "La Plata" (lost in the Bay of Biscay with over eighty lives), the "Dacia," "International," "Caroline," "Sydney Hall," "Lightning," "Morna," and various smaller vessels and tugs. During this period of Mr. Culley's service the "La Plata" was nearly lost off Portland, the "Robert Lowe" was ashore on several occasions,—once blocking Lowestoft harbour entrance for two days and narrowly escaping destruction by the sea,—and the "Caroline" had, to avoid going on the rocks in a gale, to be worked stern first under sail between Copeland Island and the mainland at the entrance of Belfast Lough. In those days it will be seen that life was somewhat hard and full of adventure, but formed an excellent training school for a young man, and work often had to be done under what would now be considered impossible conditions. With the new "Monarch," which was in 1883 considered to be quite the "last thing" in cable ships, came a new era of comparative comfort, of good discipline, a properly equipped vessel with an organised ship's company, and consequent acceleration of work.

When Mr. Culley entered the service the cables were few in number and the science of localising faults in its infancy. A week or ten days was not considered too long a time to take over a localisation test which often turned out hopelessly wrong, whereas now an hour or so in a cable hut is looked upon as slow work.

There were then only two cables to Holland, one to the Wight, the old Wexford, one at New Holland, and one each in the Forth and Tay, with one to Valentia Island for the service of the Atlantic cable.

Digitized by Google

At the transfer in 1870, those belonging to the British and Irish Magnetic company were taken over connecting Scotland and Ireland, and a few across the southern Scotch lochs to carry the wire from Glasgow to Inverary and Campbelton. Others quickly followed. In 1870 the Channel Islands cables were laid, in 1871–2 some of the islands on the West Coast of Scotland were connected, and the Stornoway cable laid. In 1873 the first Irish cable to Howth was put down, in 1875 the Isle of Man Telegraph Company was absorbed (and a new cable laid), the Scilly Company was purchased, and in 1876 the Orkney and Shetland Company, many of the cables being laid over better routes. Numerous other cables were laid year by year until the advent of the new "Monarch" in 1883. Work then increased by leaps and bounds, commencing with the introduction of the 6*d.* telegram; several rock lighthouses and light vessels were connected, the Admiralty and War Department cables came under the charge of the Submarine Department, the Submarine Telegraph Company's cables were acquired, and there are now upwards of 200 cables to maintain.

Mr. Culley either laid or assisted to lay the whole of this great system, with one or two exceptions, and his experience and length of service are probably greater than that of any other man engaged in cable-laying and repairing. He was created a Companion of the Imperial Service Order in 1903, served on the committee to investigate the damage of cables by trawlers, and was specially thanked by the Postmaster-General for his services.

He had an intense love for the sea and all work connected with it, was an expert seaman and navigator and a naval architect. He prepared several designs for a new ship prior to 1883, and was responsible for the original design of H.M.T.S. "Monarch." He designed the "Tutanekai" for the New Zealand Government for cable and lighthouse work in 1897, and was several times consulted on the building of other cable ships.

On Mr. Culley taking his farewell of the Woolwich staff, amongst which he was very highly esteemed, his many kindnesses during his time as their chief remaining in the minds of all, a spontaneous desire had borne fruit in a practical form, and he was asked to accept in affectionate remembrance a handsome silver rose bowl, suitably engraved. He was also asked to hand to Mrs. Culley a little souvenir of the "Monarch," in the shape of a silver card case, with the best of good wishes for the future.

The presentation was made on board the "Monarch" at full dress muster of "all hands," and on his leaving the ship, cheer upon cheer was raised as the departing chief went down the gangway and through the Depôt.

Like many another man who has spent a great part of his life at

Digitized by Google

sea, he has now settled down to a country life, and we hope the time he will spend at Dilbridge Hall, his home near Colchester, may be not less happy than the days spent so happily and strenuously on the successive "Monarchs."

RETIREMENT OF MR. F. H. MACHUGH.

MR. FRANCIS HUGO MACHUGH retired from the position of

FRANCIS HUGO MACHUGH.

Superintending Engineer on October 31st, 1912, under the age limit, having completed forty-one years and ten months' service.

Born on October 19th, 1852, at Edinburgh, where he received his education, Mr. Machugh entered the engineering branch of the service on January 11th, 1871, and remained at Edinburgh until April, 1878, when he was transferred to Aberdeen as stores clerk. Proceeding still further north in July of that same year he became inspector at Wick, in which section much of his time was taken up in the maintenance of the cables which connect the Orkney and Shetland groups of islands with the mainland. These were laid by

Digitized by Google

the Orkney and Shetland Telegraph Company, and afterwards purchased by the State. Outside the officers of the Submarine Department, Mr. Machugh has had experience with cable faults and repairs, probably unique, and many were the trials and dangers faced by him in those remote islands during the long winters which prevail in northern latitudes.

Thoroughly sea-hardy and genuinely fond of Neptune's element, long periods spent in all descriptions of craft had no terrors for him.

In 1893, Mr. Machugh was made an Engineer, First Class, but remained at Wick until 1902, when, owing to the death of Mr. James Gibson, Mr. Edward Campbell succeeded to the chair and Mr. Machugh became Assistant Superintending Engineer at Edinburgh. Three years later Mr. Campbell retired, and Mr. A. Eden became Superintending Engineer. On Mr. Eden's retirement, in November, 1907, Mr. T. W. Lapham succeeded him, but Mr. Lapham's occupancy of the chair was tragically all-too brief, for he only survived his transfer from headquarters for five months when death deprived the service of another estimable officer and gentleman. Thus, on April 25th, 1908, Mr. Machugh was raised from the position of Assistant to be Superintending Engineer of Scotland East District, from which position he has now retired as already stated, and it is safe to say that the Engineering Department is the poorer to-day as a consequence, for Mr. Machugh was held in high esteem by all ranks within the service as well as by a wide circle of friends outside of it. His consistent geniality and thought for his staff endeared him to all.

While stationed in Caithness, Mr. Machugh found time to exercise his patriotic instincts, and held a commission as Captain in the 1st Sutherland Highland Rifle Volunteer Brigade (2nd Seaforths). He also held high offices in masonry, having been R.W.M. of St. Fergus Lodge, Wick; Provincial Grand Senior Warden and Secretary of Caithness, Orkney and Zetland.

A man of vigorous health and robust physique, Mr. Machugh enters upon his retirement with every prospect of a long leisure, and all who have known him hope that it may be so.

It says much for the vitality of sons of Scotia that we are able to see to-day in Edinbugh three ex-Superintending Engineers with a combined age of 199 years, in the enjoyment of excellent health and vigour. I refer to Mr. Edward Campbell, who retired in 1905, Mr. A. Eden, who followed in 1907, and the latest recruit to the ranks of our veteran unemployed, Mr. Machugh. Lang may their lums reek. C. C.

Digitized by Google

STAFF CHANGES.

POST OFFICE ENGINEERING DEPARTMENT.

PROMOTIONS.

Name.	Appointment.		Date from which to take effect.
	Rank.	District.	
Moir, A.	Met. S E.	London Engr. Dist.	1 : 10 : 12
Taylor, J. D.	S.E.	Sc.E.	14 : 11 : 12
Weaver, R. A.	Asst. Supt. Engr. (P.)	Sc. W.	9 : 3 : 12
Cawood, S. D.	Asst. Engr.	Sc. E.	1 : 7 : 11
Bryant, S. G.	,,	S. Wa.	,,
Wood, A. H.	,,	London	,,
Sirett, C. J.	,,	S. Mid.	,,
Lakey, T.	,,	N. Mid.	,,
France, G. S.	,,	N. Wa.	,,
Dickson, J.	,,	S. Lancs.	,,
Newlands, T. H.	,,	N.W.	,,
Ashton, H. E.	,,	S. Wa.	,,
Eaton, G. J.	,,	N. Wa.	,,
Burton, G. M.	,,	N.E.	,,
Patterson, T.	,,	S. Mid.	,,
Scott, W.	,,	S. Wa.	,,
Roche, T.	,,	Ireland	,,
Connell, G. W.	,,	London	,,
Teggins, A. W	,,	S. Mid.	,,
Bannister, G. W.	,,	S.W.	,,
Patrick, J.	,,	Sc.E.	,,
Horton, F. D.	,,	E. in C.O.	,,
Devonshire, T. E.	,,	S. Mid.	,,
Cardrey, A. G.	,,	London	,,
Roberts, A. H.	,,	E. in C.O.	,,
Partridge, T. T.	,,	,,	,,
McNicol, A. J.	,,	S.E.	,,
Leigh, J. H.	,,	S. Lancs.	,,
Robinson, C.	,,	E. in C.O.	,,
Picker, H. F.	,,	,,	,,
Chandler, A. E.	,,	,,	,,
Watson, D. W.	,,	London	,,
Vernon, G. H.	,,	N.E.	,,
Hunter, H. J.	,,	S.W.	,,
Phillips, A. C.	,,	,,	,,
Jones, J.	,,	N. Wa.	,,
Fleming, G.	,,	Sc.E.	,,
Doak, H.	,,	Ireland	,,
Browne, F. G.	,,	N. Mid.	,,
Glover, J. B.	,,	N.W.	,,
Tebbitts, J. S.	,,	N. Wa.	,,
Jack, J. A.	,,	S.W.	,,
McCormack, W.	,,	London	,,
Harris, E. C.	,,	S. Mid.	,,
Burbridge, W. C.	Asst. Engr.	N. Wa.	1 : 7 : 11
Smith, J. I.	,,	N.	,,
Pratt, A. J.	,,	S. Lancs.	,,
Noyes, H. S.	Chf. Insp. (P.)*	E.	,,
Corless, W. H.	Ditto	S. Lancs.	,,
Grocott, J. R.	,,	N.W.	,,
Day, T. F.	,, (L.)	Test Br.	,,
Halton, E.	,, (P.)	N.Wa.	,,
Glover, J. B.	,,	N.W.	,,
McCormack, W.	,, (L.)	London	,,
Phillips, F. J.	,,	Met.	,,
Jones, T. V.	,,	,,	,,
Ray, J. W.	,, (P.)	N.W.	,,
Atkins, F.	,,	Sc. E.	,,
Robinson, F. W.	,,	Ireland	,,
Albry, W. H.	,, (L.)	S.E.	,,
Elliott, A.	,, (P.)	N. Mid.	,,
Gear, W. J.	,, (L.)	Met.	,,
Neal, W. A.	,, (L.)	,,	,,
Woodhouse, M. D.	,, (P.)	S.W.	,,
Couch, J. M.	,, (P.)	S. Lancs.	,,
Herbert, C. M.	,, (P.)	S. Wa.	,,
Pooley, R. E.	,, (L.)	Test Br.	,,
Wootton, G. A. H.	,, (L.)	E. in C.O.	,,
Land, A. E.	,, (P.)	S. Wa.	,,
Tissington, H. G.	,, (P.)	,,	,,
Cranage, H.	,, (P.)	,,	,,
Young, W. B.	,, (P.)	S.E.	,,
Barradell, D.	,, (P.)	,,	,,
Hollinghurst, W.	,, (L.)	Met.	,,
Wallis, F. J.	,, (L.)	Power	,,
Lancaster, T. S.	,, (L.)	Met.	,,
Tanner, G. F.	,, (L.)	,,	,,
Lewis, E. A.	,, (P.)	N. Wa.	,,
McIntyre, J.	,, (P.)	Sc. E.	,,
Struthers, G. A.	,, (P.)	Sc. W.	,,
Eves, W. J.	,, (P.)	N. Wa.	,,
Ancell, W. J.	,, (P.)	S.E.	,,
Cleaver, J.	,, (P.)	S. Lancs.	,,
Loftus, R. W.	,, (P.)	Test Br. Birm.	,,
Barralet, F. O.	,, (L.)	Met.	,,

* With special maximum of £240, plus £20 allowance for officers employed in London.

Digitized by Google

PROMOTIONS—*continued.*

Name.	Appointment.		Date from which to take effect.	Name.	Appointment.		Date from which to take effect.
	Rank.	District.			Rank.	District.	
Morris, G.L.	2nd. Cl. Clk.	M.	31 : 7 : 12	Bourdeaux, H. F.	Asst. Supt. Submarine	Dover	14 : 9 : 12
Miller, W.	Ditto	S. Lancs.	8 : 8 : 12	Lever, G.	Ditto.	Woolwich	,,
Riley, R.	,,	Ldn. Power Dist.	28 : 12 : 12	Gorton, S. G.	Asst. Cable Engr.	H.M.T.S. "Monarch"	18 : 9 : 12
Pollard, F.	Sub. Supt.	Woolwich	14 : 9 : 12	Firmin, E. W.	3rd Navg. Officer	Ditto	,,
Bourdeaux, J.	,,	Dover	,,				
Ramsay, F. G.	Ex Cable Engr.	Woolwich	,,				

RETIREMENTS.

Name.	Former.			Date from which to take effect.
	Rank.	District.		
Machugh, F. H.	Suptg. Engr.	Sc. E.	Superannuated	31 : 10 : 12
Blyth, W. B.	2nd Navg. Off.	H.M.T.S. "Monarch"	Retired	3 : 12 : 12

DEATH.

Kirby, J. W.	2nd Cl. Clk.	Met.	Deceased	6 : 10 : 12

TRANSFERS.

Name.	Former.		Present.		Date from which to take effect.
	Rank.	District.	Rank.	District.	
Baxter, J.	Exec. Engr.	E. in C. O.	Exec. Engr.	S. Wa.	1 : 10 : 12
Brown, J. S.	,,	,,	,,	S. Mid.	1 : 10 : 12
Cheshire, F. W.	,,	,,	,,	E.	1 : 10 : 12
Richardson, G.	,,	,,	,,	N. Wa.	1 : 10 : 12
Halton, R.	,,	N. Wa.	,,	S. Mid.	1 : 11 : 12
Beasley, B. J.	Asst. Engr.	E. in C. O.	Asst. Engr.	,,	1 : 10 : 12
Beer, G. F.	,,	,,	,,	S. Lancs.	1 : 10 : 12
Bellwood, G. F.	,,	,,	,,	N.	1 : 10 : 12
Bramwell, J. T.	,,	,,	,,	,,	9 : 10 : 12
Cowie, F. E. W.	,,	,,	,,	Sc. E.	1 : 10 : 12
Hammond, G. W.	,,	,,	,,	N. E.	9 : 10 : 12
Timmis, A. C.	,,	S. Lancs.	,,	N. Mid.	29 : 10 : 12
Lemont, G. A.	,,	N.	,,	S. E.	7 : 11 : 12
Browne, F. G.	Engr. 2nd Class	E. in C. O.	Engr. 2nd Class	N. Mid.	9 : 10 : 12

Digitized by Google

STAFF CHANGES.

TRANSFERS—*continued.*

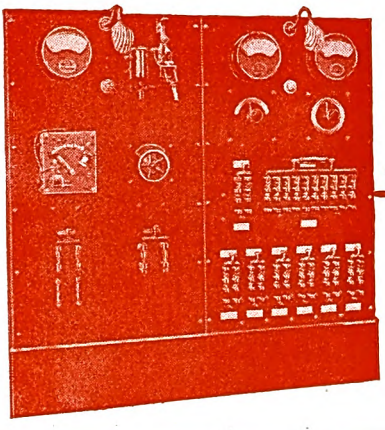
Name.	Former.		Present.		Date from which to take effect.
	Rank	District.	Rank.	District.	
Burton, G. M.	Engr. 2nd Class	E. in C.O.	Engr. 2nd Class	N. E.	1 : 10 : 12
Devonshire, T. E.	,,	,,	,,	S. Mid.	1 : 10 : 12
Dickson, J.	,,	,,	,,	S. Lancs.	1 : 10 : 12
Jones, J.	,,	,,	,,	N. Wa.	1 : 10 : 12
Jones, J. C.	,,	,,	,,	,,	1 : 10 : 12
Phillips, A. C.	,,	,,	,,	S.W.	1 : 10 : 12
Sirett, C. J.	,,	,,	,,	S. Mid.	1 : 10 : 12
Smith, W. W.	,,	,,	,,	N. E.	1 : 10 : 12
Tebbitts, J. S.	,,	,,	,,	N. Wa.	1 : 10 : 12
Teggins, A. W.	,,	,,	,,	S. Mid.	1 : 10 : 12
Thompson, J.	,,	,,	,,	N. Mid.	1 : 10 : 12
Walby, W. F.	,,	,,	,,	S.E.	1 : 10 : 12
Smith, W. W.	,,	N.E.	,,	S. Mid.	11 : 11 : 12
Wynne-Jones, A.	,,	S. Mid.	,,	N. E.	11 : 11 : 12
Stevenson, B. J.	,,	N. Wa.	,,	E. in C. O.	4 : 11 : 12
McCormack, H. C	2nd Class Clk. (P.)	Ireland	2nd Class Clerk (P.)	S. Mid.	23 : 9 : 12
Owen, W. G.	3rd Class Clerk	Met. Power	3rd Class Clerk	Met.	2 : 9 : 12
Morris, G. L.	Ditto	S.W.	2nd Class Clerk	,,	31 : 7 : 12
Riley, R.	,,	Met. S.	3rd Class Clerk	Met. Power	2 : 9 : 12
Miller, W.	,,	Se. E.	2nd Class Clerk	S. Lancs.	8 : 8 : 12
Fraser, J.	Ex. Engr.	London	Ex. Engr.	E. in C. O.	1 : 11 : 12
Osborn, W. M.	Engr. 2nd Class	,,	Engr. 2nd Class	E.	1 : 11 : 12
Wyatt, J.	Sub. Engr.	N.	Sub. Engr.	N. Mid.	4 : 11 : 12
Barralet, F. O.	Ch. Inspr.	Testing Branch	Ch. Inspr.	Met. Central	12 : 9 : 12
Maguire, J. B.	2nd Class Clerk	S. Lancs.	2nd Class Clerk	Ireland	10 : 11 : 12
Ferneyhough, F.	3rd Class Clerk	N.W.	3rd Class Clerk	S.W.	11 : 11 : 12

COMMUNICATIONS.

All Remittances and Agents' Communications should be addressed to the MANAGING EDITOR, P.O.E.E. JOURNAL, Engineer-in-Chief's Office, G.P.O. West, London, E.C.

Editorial Communications and Correspondence should be addressed to Mr. D. H. KENNEDY, Norbiggin, 26, Oakley Avenue, Ealing, W. (Telephone, Ealing 1000.)

Digitized by Google



As supplied to

The Melbourne Post Office.

POWER SWITCHBOARDS

ESTIMATES ON APPLICATION.

THE INDIA-RUBBER, GUTTA-PERCHA and TELEGRAPH WORKS CO., LTD.

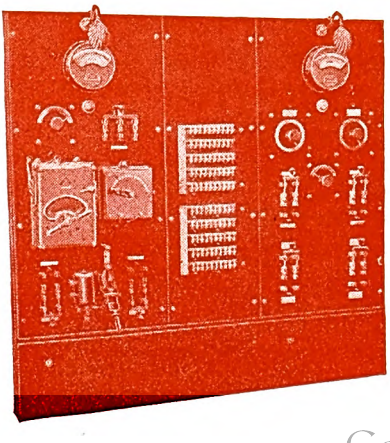
HEAD OFFICES—106, Cannon Street, London, E.C.
WORKS—Silvertown, London, E.

Telegrams—HEAD OFFICES: "Silvergray, London." WORKS: "Graysilver, London.

Branches:

BELFAST.	CARDIFF.	MANCHESTER.
BIRMINGHAM.	DUBLIN.	NEWCASTLE-ON-TYNE.
BRADFORD.	GLASGOW.	PORTSMOUTH.
BRISTOL.	LIVERPOOL.	SHEFFIELD.

For TELEGRAPH & TELEPHONE Purposes



As supplied to

The Launceston Post Office, Tasmania.

Digitized by Google

JOHNSON AND PHILLIPS LTD
VICTORIA WORKS
CHARLTON. S.O. KENT
ESTABLISHED 1875.

MULTIPLE TWIN DRY CORE TELEPHONE CABLES.

RUBBER INSULATED CABLES, PAPER INSULATED LEAD COVERED CABLES FOR POWER AND LIGHTING PURPOSES.

SWITCH BOARDS
For Power and Lighting.

FREQUENCY METERS,
Ammeter and Voltmeters.

TRANSFORMERS.

FLAME ARC LAMPS.
The "METROFLAM" Lamp burns 120 hours at one trim.
Has the LOWEST RUNNING COSTS.

Digitized by Google

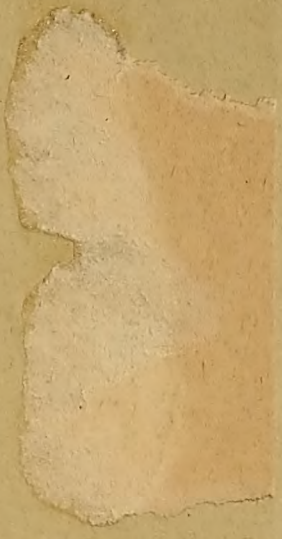
Printed and Published by H. ALABASTER, GATEHOUSE & Co., at 4, Ludgate Hill, London.

Digitized by Google

Digitized by Google

Digitized by Google

Digitized by Google



Digitized by Google